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GROWING THE FUTURE: OPPORTUNITIES TO SUPPORT DOMESTIC SEAFOOD THROUGH AQUACULTURE

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

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GROWING THE FUTURE: OPPORTUNITIES TO SUPPORT DOMESTIC SEAFOOD THROUGH AQUACULTURE

TUESDAY, JANUARY 30, 2018

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10 a.m. in room SR–253, Russell Senate Office Building, Hon. John Thune, Chairman of the Committee, presiding.

Present: Senators Thune [presiding], Blunt, Heller, Fischer, Gardner, Sullivan, Young, Nelson, Cantwell, Klobuchar, Tester, Blumenthal, and Hassan.

OPENING STATEMENT OF HON. JOHN THUNE, U.S. SENATOR FROM SOUTH DAKOTA

The CHAIRMAN. Good morning. Thank you all for being here. Today we're going to hear from some remarkable leaders in the field of aquaculture. They are working to ensure Americans have access to safe and sustainably grown seafood from right here at home.

Many of us have benefited from aquaculture, perhaps without realizing it. For years, lakes and rivers in my home state of South Dakota have been stocked with juvenile game fish raised in hatcheries. The town of Spearfish houses the Fish Culture Hall of Fame, which documents the history and importance of this type of aquaculture. The effort it took to transport fish eggs and juvenile fish in the days before refrigeration or reliable transportation is truly impressive.

Thanks to its vast coastlines, the United States has the largest Exclusive Economic Zone in the world, and yet we import 90 percent of our seafood. Half of those imports are not wild caught and are farmed in other countries around the world where we have little control over the practices and conditions in which the seafood is grown or harvested.

Domestic farming of seafood done in a safe, well-monitored manner can provide economic opportunities for all Americans, both for our coastal and inland communities. Agricultural states like mine can play an important role in providing feed for fish farms, and everyone benefits from having increased domestic seafood production.

Currently, however, those seeking to expand the domestic farming of seafood often face a confusing regulatory maze. Permits for an aquaculture farm may be required from the U.S. Army Corps

of Engineers, the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the Coast Guard, the Department of Agriculture, and the Food and Drug Administration. This overlapping web of Federal jurisdiction and lengthy, sometimes unending, permitting process can take 10 years or more, scaring many investors away. Too often, this results in entrepreneurs taking their skills, talents, and ideas overseas to a more business-friendly environment.

The United States is a global leader in how to manage wild-caught fisheries, but we regularly send our expertise, our innovation, and our dollars overseas when it comes to aquaculture. Rather than buying seafood from a global market that has seen repeated instances of labor and environmental violations, we should do a better job at home. It's time we straighten our Byzantine permitting regime and start growing some more fish.

Our witnesses today are working to promote aquaculture in the United States and will share with us some of their ideas to reduce the barriers to aquaculture and support innovative strategies for food security.

I'm pleased to welcome a fellow South Dakotan, who is bringing South Dakota soy into the fish farming market in a big way. Mr. Mark Luecke is the CEO of Prairie AquaTech, a technology company that has developed and patented a high-protein fish feed from soy meal. Prairie AquaTech is based in Brookings, South Dakota, and due to high demand in their product, they will be breaking ground on a new commercial facility this spring that will process 30,000 tons of feed per year.

As a scientist and the Director of the Thad Cochran Marine Aquaculture Center at the University of Southern Mississippi, Dr. Kelly Lucas will testify about her work overseeing a $25 million aquaculture facility, which employs cutting-edge technology, peer-reviewed research, and hands-on testing to grow fish in an environmentally responsible and economically feasible manner.

Mr. Barton Seaver began his career as a celebrity chef here in Washington, D.C., where he realized the key role aquaculture plays as a sustainable food resource and the importance of seafood in a healthy diet. He is the author of seven highly regarded books and is an internationally recognized speaker on the topic of sustainable seafood and aquaculture.

Testifying with firsthand experience in aquaculture is Mr. Don Kent, who has spent many years working to get a commercial-scale fish farm up and running off the coast of Southern California.

Aquaculture is the fasting growing food industry in the world. If encouraged in the United States, it has the potential to create jobs and boost the economy from states like South Dakota to the coasts. As Department of Commerce Secretary Wilbur Ross has stated, "This country, with its abundant coastline, should not have to import billions of pounds of seafood each year." Let's harness this opportunity and become the world leader in safe and sustainable domestic seafood production.

And with that, I will recognize our Ranking Member, Senator Nelson, who knows a little bit about seafood and oceans and coastlines and all that sort of thing.

So, Senator Nelson.

STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA

Senator NELSON. It's especially important to have aquaculture that is under conditions that are not just so nasty and putrid as we've learned about some of the aquaculture in foreign countries.

The CHAIRMAN. Yes.

Senator NELSON. And, indeed, as the Chairman has said, Florida has long been known as the fishing capital, 2,300 miles of shore land, by the way, only exceeded by Alaska. But Alaska doesn't have a lot of beaches.

[Laughter.]

The CHAIRMAN. Yes, that's true.

Senator NELSON. It's fishing-friendly weather, millions of dollars of shrimp, snapper, grouper, spiny lobster, stone crabs on the plates of Americans' restaurants, and yet there's room to grow. America consumes the second largest amount of seafood in the world, but 90 percent of it comes from other countries, and that's huge. We need to dramatically grow our domestic seafood capacity, and I think marine aquaculture should be a part of that.

A variety of fishermen, entrepreneurs, academics, and environmental groups have started to come together to figure out how we can develop a sustainable aquaculture industry. Just last year, a group at the University of Miami received a million dollar grant from the National Sea Grant college program to advance technology for captive spawning of different marine species.

I've been to the little town of Cedar Key, which back in the old days was a flourishing little coastal town, but had gone into significant decline economically when seafood had lessened as an industry, not unlike the oysters in Apalachicola Bay, and what they have done is they have started an aquaculture industry in Cedar Key, which is turning things around. So the question is: How do we turn all of this interest into commercially viable businesses?

Permitting marine aquaculture is not a simple matter. In any aquaculture permitting process, we must ensure that consumers are able to distinguish, full disclosure, between fish that have been raised in a pen and fish caught by commercial fishermen in the wild. We also need to protect our environment. Any type of permitting framework needs to ensure that we avoid harmful effects of waste, discharge, fish disease, chemical and drug use, and invasive species. That is why I'm concerned that 90 percent of our consumption in America that comes from foreign shores; they are not paying attention to these things.

I want to thank our witnesses for being here today. Donald Kent, President and CEO of Hubbs-SeaWorld Research Institute, which is a major institution in the South. And we have an opportunity as a nation to develop a sector that will bring jobs and economic growth, and especially to those little fishing communities.

So I look forward to hearing the results of this panel. And you don't have much seafood.

[Laughter.]

[The prepared statement of Senator Nelson follows:]

PREPARED STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Florida has long been called the fishing capital of the world. With roughly twenty-three hundred miles of shoreline and year-round, fishing-friendly weather, Florida is the source of hundreds of millions of dollars of shrimp, snapper, grouper, spiny lobster, and stone crab on the plates of America's restaurants and households.

Even so, there is room to grow this important sector of our economy. Although America consumes the second largest amount of seafood in the world, over ninety percent of it comes from other countries. That is a staggering percentage, Mr. Chairman.

We need to dramatically grow our domestic seafood capacity and I think that marine aquaculture should be a part of that.

A variety of fishermen, entrepreneurs, academics and environmental groups have started to come together to figure out how we can develop a sustainable U.S. marine aquaculture industry.

And Florida is leading the pack. Just last year, a group at the University of Miami received an almost one million dollar grant from the National Sea Grant college program to advance technology for captive spawning of different marine species.

The question is: how do we turn all of this interest into commercially viable businesses? This is where we have run into problems in the past.

Permitting marine aquaculture is not a simple matter. In any aquaculture permitting process we must ensure that consumers are able to distinguish between fish that have been raised in a pen and fish caught by commercial fishermen. We also need to protect our environment. Any type of permitting framework needs to ensure that we avoid harmful effects of waste discharge, fish disease, chemical and drug use, escapes and invasive species.

I also want to thank our witnesses for testifying today, especially Donald Kent, President and CEO of the Hubbs-SeaWorld Research Institute.

We have the opportunity as a nation to develop a sector that will bring jobs and economic growth to many communities across the Nation. We need to take advantage of it. I look forward to hearing our witnesses' ideas on the best paths forward.

The CHAIRMAN. But they have a few people that come through the cities in Las Vegas and consume a good amount. That's right.

As I mentioned earlier, we've got a great panel. I want to welcome Mark Luecke, who is the Managing Director and CEO of Prairie AquaTech; Dr. Kelly Lucas, Director of the Marine Aquaculture Center at the University of Southern Mississippi; Mr. Barton Seaver, who is a Chef and Author, as has been pointed out; and Dr. Donald Kent, President and CEO of Hubbs-Seaworld Research Institute.

So we'll proceed on my left, and your right, with Mr. Luecke. And if you could confine your oral remarks to 5 minutes or so, we'll make sure that your entire statement gets made part of the hearing record. And we look forward to asking you some questions.

So, Mr. Luecke, please proceed. Welcome.

STATEMENT OF MARK LUECKE, MANAGING DIRECTOR AND CEO, PRAIRIE AQUATECH

Mr. LUECKE. Chairman Thune, members of the Committee, thank you for the opportunity to speak with you this morning on aquaculture, an important topic for each of your states and for our country.

My name is Mark Luecke. I'm the Managing Director and CEO of Prairie AquaTech, a specialty feed ingredient and aquaculture technology company based in South Dakota. Like many of your constituents, I grew up on a small family farm in rural America. I graduated from business school and migrated to larger markets, pursuing a career in finance and eventually becoming an entrepreneur.

Nine years ago, a group of civic leaders recruited me back to my home state to start South Dakota Innovation Partners. We had a mission of commercializing research from our Nation's land-grant universities where innovation in agriculture was occurring. Our national security interest of protecting our country's food supply, the process of getting crops from our farmers' fields to food on our plates, became our investment thesis, more specifically, animal health and nutrition. In fact, a milestone that one of our companies will achieve this week is becoming the first USDA-licensed vaccine production facility in the State of South Dakota. This company, Medgene Labs, has a focus on foreign animal diseases that threaten our food supply.

Prairie AquaTech started with research at South Dakota State University that received both public and private funding. Technology transfer policies based on the Bayh-Dole Act allowed us to license the technology and begin the commercialization process. We constructed a 30,000-square-foot pilot-scale facility with support of the Brookings Economic Development Corporation and the Department of Commerce's Economic Development Administration. This facility, the AgTech Center for Rural Enterprise, has a mission of scaling and de-risking university technologies and starting new operating companies to support job growth in rural communities.

With further public and private support from the National Science Foundation and the USDA's Small Business Innovation Research Programs, the United Soybean Board, South Dakota Soybean Alliance, Indiana Soybean Alliance, Soy Aquaculture Alliance, and many private investors, Prairie AquaTech developed a sustainable plant-based protein ingredient that is being used in many locations around the country, including a large fish supplier to Whole Foods Market in the State of Wisconsin.

Committee members will appreciate that the seed funding provided by the NSF, USDA, and others has put Prairie AquaTech in a position to close on $60 million of private funding next month. This funding will be used to construct a large protein ingredient production facility in rural South Dakota. We take our responsibility of generating a return on both public and private investment very seriously, and we believe we have done so with Prairie AquaTech.

While Prairie AquaTech is an extraordinary example of the effectiveness of public-private partnerships, it is important for Committee members to understand that our collective work is only beginning. Despite a number of important policy statements supporting the growth of a sustainable aquaculture industry in the United States, we have made limited progress. Seafood remains one of our country's highest trade deficits in the natural resource category, while aquaculture remains one of the fastest growing segments in the agriculture outside the U.S.

We believe the reasons for our country's slow growth in aquaculture include: one, the unavailability of high-quality feed ingredients produced locally, which equates to over 50 percent of fish production costs; two, the unavailability of investment capital to construct more fish production facilities; and, three, an inefficient regulatory pathway permitting fish production facilities while pre-

serving our marine and land-based environments. An opportunity exists to improve our position.

With partner support, Prairie AquaTech has solved the first challenge of high-quality feed ingredients produced locally. Soybean farmers across many of your states have been searching for new and higher value uses of soybean meal, given an increase in supply and global competition. The process developed by Prairie AquaTech opens a new global market for our soybean farmers by eliminating allergenic proteins and sugars found in soybean meal that limit inclusion levels in aquaculture feed.

The process also increases phosphorus availability to the animal so that fish production facilities no longer discharge phosphorus in the surrounding environment. Imagine our country feeding local plant-based protein ingredients that are 100 percent digestible to fish, which have the highest feed conversion rate of all animals in an environmentally conscious manner. This is a major win for all of our constituents.

However, we need the Committee's support to increase the availability of investment capital to construct more fish production facilities in the U.S. Unlike investments in software companies, these facilities have a long lead time to design, construct, start production, and achieve break-even. This long lead time creates risk and prevents investors and lenders from supporting these projects.

We propose a public-private advisory group with a mission of recommending economic policies to the Committee that create incentives and reduce risks for private investors and lenders to support more fish production facilities.

Similarly, we need the Committee's support to establish an efficient regulatory pathway permitting fish production facilities in the U.S. Multiple Federal and state agencies claim and disclaim jurisdiction in the current regulatory pathway, which is unproductive to building an industry. The public-private advisory group would further recommend regulatory policies supporting entrepreneurs, investors, and lenders.

I appreciate the Committee members' time and attention.

Thank you very much, Chairman Thune.

[The prepared statement of Mr. Luecke follows:]

PREPARED STATEMENT OF MARK LUECKE, MANAGING DIRECTOR AND CEO, PRAIRIE AQUATECH

Chairman Thune, Members of the Committee, thank you for the opportunity to speak with you this morning on aquaculture—an important topic for each of your states, and for our country.

My name is Mark Luecke. I am the Managing Director and CEO of Prairie AquaTech, a specialty feed ingredient and aquaculture technology company based in South Dakota. Like many of your constituents, I grew up on a small family farm in Rural America. I graduated from business school and migrated to larger markets, pursuing a career in finance and eventually becoming an entrepreneur. Nine years ago, a group of civic leaders recruited me back to my home state to start South Dakota Innovation Partners. We had a mission of commercializing research from our Nation's land grant universities, where innovation in agriculture was occurring. Our national security interest of protecting our country's food supply—the process of getting crops from our farmers' fields to food on our plates—became our investment thesis; more specifically, animal health and nutrition. In fact, a milestone that one of our companies will achieve this week is becoming the first USDA-licensed vaccine production facility in the State of South Dakota. This company, Medgene Labs, has a focus on foreign animal diseases that threaten our food supply.

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While Prairie AquaTech is an extraordinary example of the effectiveness of public/private partnerships, it is more important for Committee Members to understand that our collective work is only beginning. Despite a number of important policy statements supporting the growth of a sustainable aquaculture industry in the United States, we have made limited progress. Seafood remains one of our country's highest trade deficits in the natural resource category, while aquaculture remains one of the fastest growing segments in agriculture outside the U.S. We believe the reasons for our country's slow growth in aquaculture include: (1) the unavailability of high quality feed ingredients produced locally, which equates to over 50 percent of fish production costs, (2) the unavailability of investment capital to construct more fish production facilities, and (3) an inefficient regulatory pathway permitting fish production facilities while preserving our marine and land-based environments. An opportunity exists to improve our position.

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Similarly, we need the Committee's support to establish an efficient regulatory pathway permitting fish production facilities in the U.S. Multiple Federal and state agencies claim and disclaim jurisdiction in the current regulatory pathway, which is unproductive to building an industry. The public/private advisory group would further recommend regulatory policies supporting entrepreneurs, investors, and lenders.

I appreciate the Committee Members' time and attention; thank you very much, Chairman Thune.

The CHAIRMAN. Thank you, Mr. Luecke.

Dr. Lucas.

STATEMENT OF KELLY LUCAS, PH.D., DIRECTOR, THAD COCHRAN MARINE AQUACULTURE CENTER, UNIVERSITY OF SOUTHERN MISSISSIPPI

Dr. LUCAS. Mr. Chairman and members of the Committee, thank you for inviting me to testify before you today. For the record, I'm Dr. Kelly Lucas, Director of the Thad Cochran Marine Aquaculture Center at the University of Southern Mississippi.

The Center includes approximately 100,000 square feet of culture space devoted to environmentally responsible and economically feasible marine aquaculture. Our research focuses on alleviating the bottlenecks that constrain the production of marine species. As you both have mentioned, the United States imports over 90 percent of our seafood, and half those imports are aquaculture products. We have a $14 billion seafood trade deficit.

With the growing demand for seafood and static wild-capture fisheries since the 1990s, aquaculture must continue to grow to meet this demand. While the United States has seen an increase in aquaculture production, mostly in land-based operations or in sheltered nearshore waters, we remain a minor producer. Nevertheless, we are a major supplier, an exporter of equipment, feed, and advanced technology.

We have a choice: we can continue to source our new seafood supply from abroad, or we can use our expertise to develop the domestic capacity to supply our needs. Sourcing from other countries means that the United States misses out on the opportunity to create jobs that generate wealth in our communities and provide safe, local, sustainable seafood products. There is a growing consensus among scientists, resource managers, and industry that diversification of aquaculture, to include offshore farming, could expand our capacity for local safe seafood production.

Coastal communities are recognizing that aquaculture presents a sustainable business alternative. These communities have the infrastructure, such as the boats and the processing plants, the seafood markets, and the working waterfronts, to help support operations, and aquaculture can consistently supply products to keep these businesses operating.

Other businesses, such as feed suppliers, equipment companies, and repair shops will also grow in these communities. Several offshore aquaculture operations use advanced remote sensing, unmanned systems, and artificial intelligence. This sector of the Blue Economy would also continue to expand to meet industry needs.

Regulatory uncertainty has widely been mentioned as a barrier to offshore aquaculture. The Gulf of Mexico Fishery Management Plan for Aquaculture, or the Gulf Rule, published in January 2016. The plan established a regional permitting process to manage offshore aquaculture in an environmentally and economically sustainable manner. However, investors have expressed concerns regarding the time, actual cost, and uncertainty of permit approval. Additional industry concerns with the Gulf Rule relate to the permit duration, the size of the restricted zones around the permitted areas, and community acceptance.

There is a concern that the Magnuson-Stevens Act is not the right tool for regulating aquaculture. Offshore aquaculture legislation could provide more certainty for permitting and management

of aquaculture operations. Diversification of seafood products through systems, species, and location will help build a more resilient community and will help increase production to meet demands.

The aquaculture industry has made advancements. However, there still are challenges and needs. Although we have made advancements in fish feed and have reduced reliance on forage fish, we should continue to identify alternative sustainable feeds for large-scale aquaculture. Improvements in net and cage technology have decreased chances of escapes; however, we can continue to improve the containment systems with new materials and remote monitoring technology. Continued use of unmanned systems could further improve safety, provide more timely and accurate assessments, and potentially reduce costs.

The development of hatchery capacity and the refinement of culture techniques is vital to industry development. Commercial operators need a reliable and consistent source of disease-free larval fish. Whereas some larval fish species can be reliably supplied, many other species that are high value and fast growing lack sufficient research development.

The use of selective breeding as a tool to increase production is far behind the plant and farm animal industries. Selective breeding of fish with higher growth rates can generally be completed in less time than breeding of farm animals. Domestication of new species and offshore aquaculture will require monitoring and adaptive health management plans to reduce disease and outbreaks.

Supporting aquaculture development by mechanisms similar to those used to support agriculture can help industry grow. The agricultural industry grew vastly from public support of research occurring at universities, state and Federal laboratories, and research stations spread across the Nation to bring techniques directly to farmers. Aquaculture can benefit from a similar approach of competitive peer-reviewed-based research funding and extension funding to advance the technology and the development.

Advancement of aquaculture, especially selective breeding, health management, and culture species can take multiple years for significant gains, and long-term funding programs will be critical to success. Public and private partnerships will also be important to help address industry needs, promote industry growth, and successfully transfer technology and techniques.

I appreciate the opportunity to testify before this Committee regarding aquaculture. I believe the time is now for the United States to become more self-reliant in the production of seafood.

[The prepared statement of Dr. Lucas follows:]

PREPARED STATEMENT OF KELLY LUCAS, PH.D., DIRECTOR, THAD COCHRAN MARINE AQUACULTURE CENTER, UNIVERSITY OF SOUTHERN MISSISSIPPI

Mr. Chairman and members of the Committee, thank you for inviting me to testify before you today. For the record, I am Dr. Kelly Lucas—Director of the Thad Cochran Marine Aquaculture Center (TCMAC)-University of Southern Mississippi—Ocean Springs. The Center includes approximately 100,000 square feet of culture space devoted to environmentally responsible and economically feasible marine aquaculture. Our research focuses on alleviating the bottlenecks that constrain the production of marine species. We work with government and industry to address research that will advance sustainable aquaculture on land and in coastal and marine environments. Prior to my appointment at USM, I was chief scientific officer for the

Mississippi Department of Marine Resources, the state agency with regulatory authority for managing and conserving coastal and marine resources. My testimony will provide both a science and management perspective.

The United States imports over 90 percent of our seafood and half the imports are aquaculture products. We have a $14 billion-dollar seafood trade deficit. With a growing demand for seafood and static wild capture fisheries since the 1990s, aquaculture must continue to grow to meet increasing demand. While the United States has seen an increase in aquaculture production, mostly in land-based operations or in sheltered nearshore waters, we remain a minor producer. Nevertheless, we are a major supplier and exporter of equipment, feed and advanced technology. We have a choice. We can continue to source new seafood supply from abroad or we can use our expertise to develop the domestic capacity to supply our needs. There is a risk in continuing to source aquaculture products from abroad. Several of the major producer countries do not have the environmental standards we have in the United States and they do not have robust disease management regulations. Further, they tend to lack transparency which creates easy avenues for fraud and quality issues. New supply is also often from countries with political uncertainty or geopolitical instability that can threaten the supply chain and create food insecurity. Importantly, sourcing from other countries means the United States misses out on the opportunity to create jobs that generate wealth in our communities and provide safe, local, sustainable, seafood products.

Opportunities

There is growing consensus among scientists, resource managers and industry that diversification of aquaculture to include offshore farming could expand our capacity for local, safe, seafood production. Even some environmental groups have expressed interest in the potential for aquaculture to supply a healthier protein with less impact than that from other animal sources. This is not to say that there is no opposition to aquaculture. However, public engagement and outreach on advances in aquaculture can help educate consumers and address concerns. By siting aquaculture farms away from sensitive habitats in deep waters with adequate currents the potential for pollution is reduced. Improved materials for containment and remote sensing technology has decreased the likelihood of fish escapement. Remotely controlled feeding and observation systems have helped create a mechanism for reducing over-feeding and improved feeds have reduced the reliance on forage fish.

The economic success of sustainable commercial operations abroad and in Hawaii, Maine and New Hampshire have created a renewed optimism for offshore commercial development. Coastal communities are recognizing that aquaculture presents a sustainable business alternative. These communities have the infrastructure such as boats, processing plants, seafood markets and working waterfronts to help support operations and aquaculture can consistently supply products to keep these businesses operating. Other businesses, such a feed suppliers, equipment companies and repair shops also grow in these communities. Several offshore aquaculture operations use advanced remote sensing, unmanned systems and artificial intelligence. This sector of the blue economy would also expand to meet industry needs.

Businesses need regulatory certainty to reduce the risk of investment. Regulatory uncertainty has been widely mentioned as a major barrier to offshore aquaculture. The Gulf of Mexico Fishery Management Plan for Aquaculture in the Gulf of Mexico (Gulf Rule) published in January of 2016. The plan established a regional permitting process to manage offshore aquaculture in an environmentally sustainable manner and NOAA worked with Federal permitting agencies to create a coordinated permit process. The estimated cost for engineering, siting and environmental assessment to permit a commercial structure under the Gulf rule has been estimated at $1 million dollars. However, investors expressed concerns regarding the time, actual cost and uncertainty of permit approval. Additional industry concerns of the Gulf Rule relate to permit duration, size of restricted zones around permitted areas and community acceptance. The day the Gulf Rule was announced several groups filed a lawsuit challenging NOAA's authority for permitting aquaculture under the 2007 Magnuson-Stevens Act. There is a concern that the Magnuson-Stevens Act is not the right tool to regulate aquaculture. Offshore aquaculture legislation could provide more certainty for permitting and management of aquaculture operations.

Opportunities also exist for the growth of land-based and near-shore aquaculture. Land-based aquaculture in recirculating closed loop systems is advantageous for numerous reasons. Land-based, recirculating systems provide a controlled environment that allows year round production, increased biosecurity that reduces the occurrence and spread of disease, and the capability for reusing and recycling water to decrease the waste and increase sustainability. Because such systems are self-contained and

decoupled from a water source, they can be located almost anywhere near the markets they serve where they create local jobs and supply safe, fresh, local, seafood for consumers. Near-shore aquaculture in the United States also has been increasing. Shellfish aquaculture has expanded into new geographic areas and production has increased significantly along coastal shorelines. Seaweed aquaculture has been increasing in several regions of the United States. Growth of near-shore finfish operations also has occurred in regions with nearshore water-depths sufficient to support the structures. Diversification of seafood products through systems, species and location will help build a more resilient industry and will help increase production to meet demand.

Challenges and Needs

For the aquaculture industry to be successful on a scale necessary to meet demand, there are things that still need to be addressed. Although we have made advancements in fish feed and have reduced reliance on forage fish, we should continue to identify alternative sustainable feeds for large-scale aquaculture. Improvements in net and cage technology have decreased chances of escapes; however, we can continue to improve containment systems with new materials and remote monitoring technology. Unmanned systems and artificial intelligence can aid operators in tasks such as cleaning cages, feeding fish and detecting potential problems. This technology decreases reliance on divers and helps improve safety of operations. Continued use of these systems could further improve safety, provide for more timely and accurate assessments, and potentially decrease cost. The development of hatchery capacity and refinement of culture techniques is vital to industry development. Commercial operators need a reliable and consistent source of disease-free larval fish from documented broodstock. Whereas some larval fish species can be reliably supplied, many other species that are high value and fast-growing lack sufficient research development. Other challenges for hatcheries include a shortage of customers to purchase fish and keep the hatchery operating while waiting on domestic industry development. The use of selective breeding as a tool to increase production is far behind the plant and farm animal industries. Selective breeding of fish with higher growth rates can generally be completed in less time than breeding of farm animals. Fish convert feed to meat more efficiently than terrestrial animals and the ability to produce a steady fish supply can meet the increasing demand for protein. Fish health management is also critical to increasing aquaculture production. For some species raised in re-circulating systems or pond culture disease has been well studied and management for prevention has been important for success. Domestication of new species and offshore culture will require monitoring and adaptive health management plans to reduce disease and outbreaks.

Supporting aquaculture development by mechanisms similar to those used to support agriculture can help industry grow. The agriculture industry grew vastly from public support of research occurring at universities, state and Federal laboratories and research stations spread across the Nation to bring techniques directly to farmers. Aquaculture can benefit from a similar approach of competitive peer-reviewed based research funding and extension funding to advance research and development. Advancement of aquaculture, especially selective breeding, health management and culture techniques can take multiple years for significant gains and long-term funding programs will be critical to success. Public and private partnerships also will be important to help address industry needs, promote industry growth and successfully transfer technology and techniques.

Concluding Remarks

I appreciate the opportunity to testify before this Committee regarding aquaculture. I believe the time is now for the United States to become more self-reliant in the production of seafood. We can create jobs and reduce the seafood trade deficit while supplying safe, local, sustainable, seafood. Diversification of aquaculture production in addition to commercial fishing can help supply seafood to help meet the growing demand. Government, universities and industry working together can help create regulatory certainty, address research needs and advance sustainable aquaculture.

The CHAIRMAN. Thank you, Dr. Lucas.
Mr. Seaver.

STATEMENT OF BARTON SEAVER, DIRECTOR, SUSTAINABLE SEAFOOD AND HEALTH INITIATIVE, CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT, HARVARD T. H. CHAN SCHOOL OF PUBLIC HEALTH

Mr. SEAVER. Hi. Good morning, Chairman Thune and all the Ranking Members here. An incredible opportunity and honor to be here representing my home state of Maine and all of the coastal communities along this great Nation's shorelines.

I want to talk a little bit today just about why aquaculture matters, why seafood is important to us, and a little bit of the opportunity that resides within it for us to look ahead, too, as so many of my fellow panelists have spoken about, and I look forward to continuing conversation.

So in Maine, we have a slightly unique cultural dynamic. There we honor the legacy and the presence of the lobster fisheries specifically, also the fin fisheries. The working waterfronts that they support, the sophisticated cold chain supply systems, individual boat operators, owners, ice producers, the cold chain, all of it there. There's a strong apprentice program, a strong presence and legacy of this industry. And there we view lobstering and fishing as a noble profession, one that is very essential to the state's identity. But this genuflection to the men and women harvesting seafood is not shared by all communities in America, and rarely so actually only in specific areas around the country.

When we, as citizens, as an analogy, envision an agricultural scene, we envision amber waves of grain, the fruited plain, the picturesque red barns. We get this. This is American iconography, a conjuring that represents and renders farming as the best possible use of fertile land. But when we think of the ocean, it's often wilderness that captures our imaginations about it. We value the open sea because the hand of man is simply not present. But I argue that we must emotionally embrace farming our seas and fishing them so as we do farming the land. And this is an important part of putting the culture into aquaculture.

There is more America underwater than there is above it. As Chairman Thune mentioned, we have more—there is more coastline in America and the longest—the largest Exclusive Economic Zone. Recently, a study mapped global marine aquaculture productivity concluded that in an area the size of the ocean, just an area of the ocean the size of Lake Michigan, we could sustainably farm as much seafood as is currently captured globally in the wild. With that amount of opportunity, it is incredible.

And as railroads once allowed our expansion westward, aquaculture will be the vehicle that allows us to pioneer our path into a new economic geography. In eras past, the rallying cry was, "Go west, young man!" and it was 40 acres and a mule that allowed us to succeed. And today, that same rallying cry is, "Go west, young person!" It's going to be 20 acres of marine lease and an outboard that is going to get us there.

In a paper by esteemed colleague Michael Rubino and Gunner Knapp, they say that the biggest impediment to developing American aquaculture is the industry's lack of social license. And an industry gains social license when the general public understands the benefits that it brings to the table, and for aquaculture, that is a

healthier citizenry. It is economic opportunity and a chance to maintain out leadership on a global stage presenting a consistent model for responsibly and ecologically sustainable practices.

Seafood is an important part of our diet, as Americans, and should be more so. If Americans followed our own government's recommendations to eat omega-rich seafood twice a week, 55,000 lives would be saved annually from stroke and heart disease, and yet only 1 in 10 Americans follow these regulations. It's not a stretch to say that America—a "Made in the USA" stamp of sustainably produced domestic aquaculture could inspire confidence and lead to increased consumption.

Further, the average age of fishermen in this country is growing, and few participants are joining their ranks. A lack of jobs and prosperity in wild fisheries has led young people in coastal communities to look for work elsewhere. This is particularly true in Maine. Aquaculture could provide that missing opportunity in an exciting and innovative new industry, and this is already happening, beginning to happen, in Maine, where sons and daughters of fishermen are operating dozens of oyster, mussel, seaweed, fish farms.

But I cannot stress enough how much aquaculture must coexist in parallel with our wild fisheries, as they will augment each other and ultimately raise the profile and value of each of each other's products.

And I would also like to touch briefly on the notion that about how investment in and growth of domestic aquaculture will affect our trade imbalance in seafood. I think it's very important from a public health perspective that we acknowledge that access to sustainable healthy protein, healthy seafood, is imperative in America's society. What we should be focusing on is growing increased consumption, going from 15 pounds per person per year to 25 pounds, and it is within that increased consumption that America's aquaculture industry should find its opportunity to provide for America's table.

A thoughtful and inclusive approach to aquaculture regulation will set in motion a very compelling American success story, will author a new chapter in our economic history, and I ask this Committee, in its wisdom, to consider regulations that are offered—that are oriented to and governed by regional knowledge. One size does not fit all. And though we need overarching regulations, please consider that there are cultures that will be commended—that will be purposed with executing aquaculture. And any aquaculture farm must be ecologically and culturally relevant to the area in which it is produced.

It is my hope ultimately that my son, 16 months old, grows up on the coast of Maine in the—with all of the opportunity that aquaculture presents to him, amongst thriving neighbors, and with a dream that he, too, might nobly provide for America's tables.

Thank you so much for the opportunity to be here today.

[The prepared statement of Mr. Seaver follows:]

PREPARED STATEMENT OF BARTON SEAVER, DIRECTOR, SUSTAINABLE SEAFOOD AND HEALTH INITIATIVE, CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT, HARVARD T. H. CHAN SCHOOL OF PUBLIC HEALTH

Good afternoon Chairman Thune, Ranking Member Nelson and all other members of the committee. I am honored to be here speaking on behalf of my neighbors in coastal communities throughout America. We have very good reason to consider the promising future of aquaculture.

I began my career as a chef here in Washington, D. C. I used that platform to espouse a negative view of aquaculture. My opinion was based on a limited scope of information I gathered from environmental advocacy groups concerning the state of the aquaculture industry at that point in time 15 years ago. As my career progressed, I gained an understanding of the full context of aquaculture's impact, both positive and negative.

I left the restaurant industry 8 years ago and took an assignment as a National Geographic Explorer. My mission focused on marine ecosystems, discovering strategies to minimize human impact upon them. I came to understand that the whole concept of environmental sustainability hinges on thriving coastal communities. Certainly, the coastal way of life depends on a resilient underlying marine ecosystem to which we must be good stewards. But I believe that in aquaculture, we can sustainably capitalize on the positive impact marine ecosystems have on these communities and the wider population.

I now live in a Maine coastal community where I am raising my son. His ability to thrive depends on the well-being of the entire community. As such, this topic has become a deeply personal issue.

In Maine we honor the legacy of the lobster fishery that supports working waterfronts, a sophisticated cold chain system, bait suppliers, individual boat owners, and a strong apprentice program. We view lobstering as a noble profession, one essential to the state's identity. But this genuflection to the men and women harvesting seafood is not widespread beyond Maine.

When we as citizens envision an agricultural scene, we see amber waves of grain, the fruited plains, stoic white farm houses and picturesque red barns; a conjuring that renders farming the best possible use of fertile land. We value land for our presence there. But when we think of the ocean, it's the wildness that captures our imaginations. We value the open sea because the hand of man is not present. I argue that just as we emotionally embrace farming the land, so must we embrace fisheries and aquaculture.

The diesel engine pushed Americans westward to manifest destiny. But we've hit hard limitations—depleted aquifers, soil erosion, and changing weather events—to further increasing agriculture production on land. We need to look to the oceans for long-term food security. More of America sits under the ocean than above it. We have the longest coastline in the world and the largest exclusive economic zone. In a study mapping the global potential for marine aquaculture conducted by a group of University of California at Santa Barbara scientists concludes that in an area of the ocean the size of Lake Michigan that is ripe for aquaculture, we could sustainably farm fish equal to the amount of seafood currently caught globally in the wild today.[1]

As railroads facilitated westward expansion, aquaculture will pioneer a path into an ocean geography that will become Blue America. In eras past, the rally cry was "Go west, young man!" And the means to settlement and prosperity was 40 acres and a mule. Today, that same sentiment comes in the declaration "Go wet, young person!" It will be 20 acres of marine lease and an outboard motor that will get us there.

In a paper on the political economics of marine aquaculture in the United States,[2] scientist Gunner Knapp, recently retired from the University of Alaska, and Michael Rubino, Director of the Office of Aquaculture at NOAA's Fisheries Service, say the biggest impediment to developing American aquaculture today is the industry's lack of social license. An industry gains social license when the general public understands the benefits it brings to the table. For aquaculture, those include a healthier citizenry as Americans will have better access to more seafood; economic opportunity by way of new jobs, and, a chance to maintain our leadership on the world

[1] Mapping the global potential for marine aquaculture *http://www.nature.com/articles/s41559-017-0257-9*

[2] The Political Economics of Marine Aquaculture in the United States *http://www.tandfonline.com/doi/abs/10.1080/23308249.2015.1121202?journalCode=brfs21*

stage as a consistent model for responsible and ecologically sustainable aquaculture practices.

Seafood is an important ingredient in a healthy diet. Fish—compared to cows, sheep, pigs and chickens—levy the least environmental impact to produce, and their protein is healthier for the human diet. If Americans followed our own government's recommendation to eat omega-3 rich seafood just two times a week, 55,000 lives would be saved annually from heart disease and stroke annually.[3] And yet, only 1 in 10 Americans follow these guidelines.[4] It is not a stretch to say that developing the United State aquaculture industry as a trusted source for seafood would lead to increased consumer confidence and consumption.

This nation was founded on cod and the backs of the men and woman who fished them. The ocean economy spurred the economic and political freedoms we enjoy today and we have watched as it atrophied before our eyes. The once mighty North Atlantic fishery struggles mightily now. While we manage our wild fisheries well, the bounty is a fraction of what it once was.

The average age of fishermen is increasing and few new participants join their ranks. A lack of wild fishing jobs drives young people in coastal communities to seek work elsewhere. Aquaculture could provide that missing opportunity in an exciting and innovative industry. It could offer a fishing family's son or daughter an opportunity, a step towards to owning a small business and a chance to remain in their coastal community and contribute to its evolving maritime heritage. This is already happening in Maine where sons and daughters of fishermen operate dozens of oyster, mussel, seaweed, and fish farms.

I cannot stress enough that for all of the opportunity aquaculture presents, it exists in parallel with our storied wild fisheries. Aquaculture is not a replacement for wild fisheries but an augmentation to their culture and economy that will raise the profile and value of all American seafood.

I want to touch briefly on the assertion that an investment in American aquaculture will level the trade imbalance between domestic and foreign seafood. We should not seek to decrease imports of healthy seafood but work to increase overall seafood consumption to drive demand seafood raised in our own waters. As the goal is to get more people eating more seafood for a healthier America, we cannot vilify responsibly sourced seafood imported from other parts of the world. Doing so would diminish consumer confidence in all seafood.

The committee holds this hearing at a unique moment because we have the opportunity to be architects of a substantial new economy. A thoughtful and inclusive approach to regulating aquaculture will set in motion a compelling American success story. I ask this committee to set regulations that are oriented to and governed by regional knowledge. While we need overarching guidelines, one size will not fit all as aquaculture is a product of a community and is unique to the environment in which it is executed. Likewise, we must move forward with the understanding that not all forms of aquaculture are culturally or ecologically appropriate for all places. Please consider giving residents of those places—especially First Nations People and those with a significant heritage in fishing—the chance to decide what aquaculture means for them and let them design regionally specific methods in pursuit of the seemingly inexhaustible potential of America's Blue Economy.

It is my hope that my son grows up surrounded by opportunity, thriving neighbors, and a dream to nobly provide food for America's tables. Again, I thank you for the honor of appearing before you today. And I stand ready to answer any questions you or your staff may have now or in the future.

The CHAIRMAN. Thank you, Mr. Seaver.

I have to step out momentarily, so I'm going to hand the gavel over to Senator Blunt.

But, Mr. Kent, Dr. Kent, good to have you here. Please, proceed.

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[3] Association between Dietary Factors and Mortality from Heart Disease, Stroke, and Type 2 Diabetes in the United States *https://jamanetwork.com/journals/jama/article-abstract/2608221*

[4] Scientific Report of the 2015 Dietary Guidelines Advisory Committee *https://health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific-Report-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf*

STATEMENT OF DONALD B. KENT, PRESIDENT AND CEO, HUBBS-SEAWORLD RESEARCH INSTITUTE

Mr. KENT. Thank you. My name is Don Kent, and I'm the President and CEO of Hubbs-SeaWorld Research Institute. I want to thank Chairman Thune, Ranking Member Nelson, and the other members of the Committee for this opportunity to discuss the opportunities and concerns arising from the development of marine farming in our Nation's waters.

I've been involved in aquaculture research for over 40 years and have worked on research involving the culture of a wide range of species, including plants, shellfish, and finfish.

Our Institute is a nonprofit scientific research organization dedicated to advancing a healthy ocean environment to the benefit of both human and animal populations. As a part of this mission, we have developed a comprehensive aquaculture research program looking at the feasibility of not only restoring depleted marine stocks, but also developing a broader sustainable seafood production capability.

Our Nation leads the world in the production of farm products except for seafood. Presently, the United States is a minor player in aquaculture production, but the second largest consumer of seafood. The resulting dependence on importing farmed seafood from other countries could be reversed by the United States using its existing regulations to demonstrate best management practices for seafood in the open ocean. The lack of a Federal management framework to grow fish in the Exclusive Economic Zone is a significant barrier to reaching this goal and presents an almost insurmountable barrier to investors that would rather invest in farms in other countries and import the product into our Nation.

Our Nation has invested heavily in marine aquaculture research, resolving issues like fishmeal replacement, disease prevention and management, open ocean equipment engineering, and domesticating regionally appropriate species for culture, and our Institute and its collaborators have contributed significantly to setting the stage for offshore farming.

The research we have conducted over the decades has not gone unnoticed. To demonstrate the potential for open ocean farming, the Institute has provided juvenile fish reared in our hatchery to farms off the coast of Baja California, Mexico, farms funded and operated by Americans. These farms have expanded well beyond the demonstration scale and are now selling the majority of their product to U.S. markets.

For more than a decade, we have been working without success to permit a farm off the coast of Southern California. This one farm, while using less than a square kilometer of open ocean space, would produce five times more seafood than all the commercially harvested seafood in San Diego County while supporting 70 farm jobs as well as an additional 200 or more indirect jobs. The problem is not a lack of regulatory process, but, rather, the lack of Federal research—excuse me—the Federal leadership in managing that process.

Agencies like the Army Corps of Engineers and the Environmental Protection Agency know what permits are needed and understand their authorities. The limiting factor has been a lack of

defined leadership for the required environmental review. As both the Corps and the EPA were disinclined to accept that responsibility, in 2014, we submitted permit applications to these agencies, but it took 7 months before the EPA finally agreed to lead a single consolidated NEPA review process in collaboration with the Corps and NOAA fisheries under the auspices of a multiagency MOU.

After both the EPA and Army Corps had published their individual notices of intent in the *Federal Register* and had each received comments following the extended public review periods, the wheels came off the wagon. Eleven months after agreeing to take the lead, the then EPA Regional Director recanted the agreement, forcing two disconnected and independent reviews, and cost us more than a year of lost effort.

A year later, NOAA fisheries offered to undertake the lead even though their agency did not need to issue a permit for the project. Hopefully, we are now moving forward and are trying to assure our understandably nervous investors that we have a viable permitting process to guide us.

The need for expanding domestic aquaculture and recognizing its net positive environmental impact has become more prevalent over the past decade. Numerous studies point to marine farming as the most sustainable way to grow animal protein for human consumption. Marine conservation groups as diverse as the Coastal Conservation Association, the Nature Conservancy, and World Wildlife Fund are interested in improved technologies and best practices, enhancing a positive role of aquaculture in the U.S., reducing the Nation's reliance on imported farmed seafood and commercially caught wild finfish, that are far more difficult to manage and far more subject to fluctuations in the ocean environment.

Last week, the Yale School of Forestry and Environmental Studies published an article stating "if you look at best management practices in aquaculture, there's nothing comparable in terms of land-based meat production that has such a low level of environmental impacts."

The limited scope of the U.S. marine aquaculture industry will not expand without access to the offshore Federal waters. Urgency needed is clear authority for U.S. aquaculture entrepreneurs to operate in the EEZ while complying with existing regulations and doing so and creating a viable, competitive business model.

Marine aquaculture in the EEZ promotes public health, food security, and American economic interests, but only if government provides clear and timely legal authority for our private sector's mission and removes unwarranted regulatory obstacles. We need a consistent, predictable, efficient permitting process to incentivize American investors, keeping their capital here, thereby creating a new paradigm for domestic seafood production toward higher food security, lower transport costs, more American jobs, and a larger tax base, and rebirth of our working waterfronts.

Thank you very much for this opportunity.

[The prepared statement of Mr. Kent follows:]

PREPARED STATEMENT OF DONALD B. KENT, PRESIDENT AND CEO, HUBBS-SEAWORLD RESEARCH INSTITUTE

My name is Donald Kent and I am the President and CEO of the Hubbs-SeaWorld Research Institute. I want to thank Chairman Thune, Ranking Member Nelson, and the other Members of the Committee for this chance to discuss opportunities and concerns arising from the development of marine farming in our Nation's waters. I have been involved in aquaculture research for over 40 years and have worked on research involving the culture of a wide range of species including plants, shellfish and finfish. In addition to these brief remarks, I will append an annotated list of references for the Committee's consideration.

Our Institute is a non-profit, scientific research organization dedicated to advancing a healthy ocean environment to the benefit of both human and animal populations. As a part of this mission, we have developed a comprehensive aquaculture research program looking at the feasibility of not only restoring depleted marine fish stocks, but also developing a broader sustainable seafood production capability.

Our nation leads the world in the production of farmed products except for seafood. Presently, the United States is a minor player in aquaculture production but the second largest consumer of seafood. The resulting dependence on importing farmed seafood from other countries could be reversed by the United States using its existing regulations to demonstrate best practices for farming seafood in the open ocean. The lack of a Federal management framework to grow fish in the Exclusive Economic Zone is a significant barrier to reaching this goal, and presents an almost insurmountable barrier to investors that would rather invest in farms in other countries and import the product into our markets.

Our nation has invested heavily in marine aquaculture research resolving issues like fish meal replacement, disease prevention and management, open ocean equipment engineering and domesticating regionally appropriate species for culture, and our Institute and its collaborators have contributed significantly to setting the stage for offshore farming. The research we have conducted over the decades has not gone un-noticed. To demonstrate the potential for open ocean farming, we have provided juvenile fish reared in our hatchery to farms off the coast of Baja California, Mexico; farms funded and operated by Americans. These farms have expanded well beyond the demonstration scale and are now selling the majority of their product to U.S. markets.

For more than a decade we have been working, without success, to permit a farm off the coast of southern California. This one farm, while using less than a square kilometer of open ocean surface area, would produce 5 times more seafood than all the commercially harvested seafood in San Diego County while supporting 70 direct farm jobs as well as additional 200 or more indirect jobs. The problem is not a lack of regulatory process, but rather the lack of Federal leadership to manage that process.

Federal agencies, including the Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA) have relevant permitting authorities and understand those authorities. The limiting factor has been a lack of defined leadership for the required environmental review, as neither the Corps nor the EPA has been willing to accept that responsibility. In 2014 we submitted permit applications to these agencies, but it took seven months before the EPA finally agreed to lead a single, consolidated NEPA review process in collaboration with the Corps and NOAA Fisheries under the auspices of a multi-agency Memorandum of Understanding. After both the EPA and Corps had published their individual Notices of Intent in the *Federal Register* and had each received public and various agency comments following extended public review periods, the wheels came off the wagon. In March 2016, 11 months after the EPA agreed to lead the joint NEPA review, the Regional Director of the EPA recanted the agreement thereby bifurcating the conjoined environmental reviews into two, disconnected and independent reviews.

A year later in the spring of 2017, NOAA Fisheries, based on their unique aquaculture and marine resources expertise, offered to undertake the lead agency role for the requisite NEPA review even though their agency does not have permitting authority for aquaculture at this time. (NOAA Fisheries is consulted by EPA and the Corps via their respective consultation processes.) We are hopeful that we now have a process to move the environmental review process forward with NOAA Fisheries leading NEPA review, and the EPA and the Corps as cooperating or participating agencies and are trying to assure our understandably nervous investors that this time there will be no recanting of the process.

As the recognition over the past decade of the need for expanding domestic aquaculture has become more prevalent, far more attention is being paid to the potential for a net benefit to the environment that would result from farming more seafood.

Numerous studies now point to marine farming as the most sustainable way to grow animal protein for human consumption. Marine conservation groups as diverse as the Coastal Conservation Association, The Nature Conservancy and the World Wildlife Fund are exploring how improved technology and best practices can enhance the potential positive role aquaculture could play in reducing the U.S. seafood market's sole reliance on commercially caught wild finfish and imported farmed seafood products. Many studies now point to the need to turn to aquaculture to meet the growing demand for protein since terrestrial based animal production puts far more pressure on limited natural resources. Last week the Yale School of Forestry and Environmental Studies published an article in which Dr. Steve Gaines, the Dean of the Bren School of Environmental Science & Management at UC Santa Barbara, stated: *"If you look at best management practices in aquaculture, there's nothing comparable in terms of land-based meat production that has such a low level of environmental impacts."*

The limited scope and size of today's U.S. marine aquaculture industry simply cannot substantially expand without access to the offshore waters controlled by the Federal Government, the Exclusive Economic Zone (EEZ). However, access alone is not sufficient, and will not create the fertile environment for private investment in U.S. marine aquaculture. What is urgently needed is clear legal authority for U.S. aquaculture entrepreneurs to operate in the EEZ in compliance with existing regulatory programs toward implementation of viable business models that will prosper in the highly competitive global seafood marketplace.

Offshore marine aquaculture in the EEZ holds tremendous potential for advancing the public health, food security and economic interests of Americans, but those interests can only be served if government provides the legal authority for the private sector to fulfill that mission without unwarranted regulatory obstacles. We need to establish a consistent, predictable and efficient permitting process that will incentivize American investors into keeping their investment capital in this country to create a new paradigm for domestic seafood production thereby leading to higher food security, lower transportation costs to our seafood supply chain, more American jobs, a larger tax base and greater utilization of our working waterfronts.

Additional Comments and References[1] to Augment the Testimony Presented by Donald Kent to the Commerce, Science and Transportation Committee of the United States Senate's hearing on *Growing the Future: Opportunities to Support Domestic Seafood through Aquaculture.*

Over the last 20 years, responsible environmental stewardship has become the proven business model in the states or territorial waters of Maine, Washington, Hawaii and Puerto Rico where commercial scale net pens have been operated to farm Atlantic salmon, Almaco jack or cobia. Additionally, shellfish farming is expanding in Alabama, Alaska, California, Connecticut, Florida, Hawaii, Louisiana, Maine, New Hampshire, New Jersey, New York, Maryland, Massachusetts, North Carolina, Oregon, Rhode Island, Virginia, South Carolina and Washington, growing abalone, clams, oysters, geoduck, mussels or scallops. These farms have been managed in compliance with state and Federal regulations with Best Management Practices, along with the provisions of long-term lease agreements with the states or territory. All such operations are conducted with regulatory transparency supported by environmental monitoring data and periodic reporting for these operations in publicly available documentation required by state and Federal agencies.

It is abundantly clear: the limited scope and size of today's U.S. marine aquaculture industry simply will not substantially expand without access to the majority of offshore waters that are controlled by the Federal Government. Large-scale marine aquaculture production in the United States would create the ability to:

- Close a significant gap in U.S. food security (availability) through the farming of seafood products in U.S. waters rather than relying as the United States currently does on foreign seafood sources for 90 percent of the seafood consumed by our citizens.
- Create ancillary equipment and service businesses and new jobs within coastal and inland communities.
- Accelerate technological development to reduce production costs and minimize adverse environmental effects.
- Maintain working waterfronts and build upon the existing and unique knowledge, skills and abilities possessed by commercial fishers.

[1] Content compiled by Paul W. Zajicek, Executive Director of the National Aquaculture Association for its Marine Aquaculture Committee

- Preserve rural and coastal communities by providing economic development and diversification opportunities and jobs consistent with community desires for a sustainable future.

While these potential outcomes are well-documented,[2] we have yet to make any significant advances in U.S. marine aquaculture production in the 37 years since passage of the National Aquaculture Act of 1980. Currently marine farming production is approximately 45,500 tons valued at $327 million and supplies about 3 percent of U.S. seafood consumption. Federally managed waters beyond coastal state boundaries, termed the Exclusive Economic Zone, encompass 4.4 million square miles (11.3 million square kilometers). A U.S. study estimated that 195 square miles (500 sq. km) of ocean, managed under existing regulations, could produce 1.3 billion pounds (600,000 metric tons) or more of high quality seafood.[3] Theoretically, the farming of 970 sq. miles (2,500 sq. km), an area representing .0002 percent of the Exclusive Economic Zone, less than half the size of Delaware, would double U.S. edible seafood production or an area the size of the Pentagon could produce 220 million pounds (100,000 MT). A doubling of U.S. aquaculture production to about 1 million tons could create an estimated additional 50,000 farm and non-farm jobs.[4]

Over the last 20 years, rather than acknowledging the many advances in marine aquaculture production practices and successful management strategies for adverse environmental impacts, the environmental community continues to restate a variety of potential adverse environmental effects of aquaculture based on outdated production methods and standards.[5] We note the U.S. Environmental Protection Agency has held authority under the Clean Water Act to regulate discharges from fish farms for decades. During a four-year period, 2000–04, the agency completed a detailed technical review of its standards and modern aquaculture methods, including those used for marine aquaculture. The Clean Water Act regulations for aquaculture met all standards of environmental protection mandated by Congress and additional regulatory standards were found to be unwarranted. Current regulatory authority exists to appropriately protect marine water quality and benthic environmental systems, manage fish escapes, and require responsible drug and chemical use. Basic and applied research supported by governmental agencies and the private sector has led to continuing improvements in reducing the use of essential fish meal and fish oil components in pelleted aquaculture feeds.

Over the last 20 years, responsible environmental stewardship has become the proven business model in the states or territorial waters of Maine, Washington, Hawaii and Puerto Rico where commercial scale net pens have been operated to farm Atlantic salmon, Almaco jack or cobia. Additionally, shellfish farming is expanding in Alabama, Alaska, California, Connecticut, Florida, Hawaii, Louisiana, Maine, New Hampshire, New Jersey, New York, Maryland, Massachusetts, North Carolina, Oregon, Rhode Island, Virginia, South Carolina and Washington growing abalone, clams, oysters, geoduck, mussels or scallops. These farms have been managed in compliance with state and Federal regulations with Best Management Practices, along with the provisions of long-term lease agreements with the states or territory. All such operations are conducted with regulatory transparency supported by environmental monitoring data and periodic reporting for these operations in publicly available documentation required by state and Federal agencies.

The inherent sustainability of aquaculture production as practiced in the United States is recognized by marine education organizations, academic institutions and national agricultural and aquaculture organizations as vividly described in recent videos:

- Aquarium of the Pacific, *Perspectives on Marine Aquaculture in California and the U.S.: https://vimeo.com/211721422* and *Marine Aquaculture: a tool for conservation: https://www.youtube.com/watch?v=ygoU5knT7ww.*
- University of Miami, *The Business of Aquaculture: https://www.youtube.com/watch?v=2vduoM7hYKA.*

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[2] Rubino, Michael (ed). 2008. Offshore Aquaculture in the United States: Economic Considerations, Implications & Opportunities. U.S. Department of Commerce; Silver Spring, MD; USA. NOAA Technical Memorandum NMFS F/SPO–103

[3] Nash, C.E. 2004. Achieving Policy Objectives to Increase the Value of the Seafood Industry in the United States: The Technical Feasibility and Associated Constraints. Food Policy 29:621–641.

[4] Knapp, G. and M.C. Rubino. 2016. The political economics of marine aquaculture in the United States. Reviews in Fisheries Science and Aquaculture 24(3): 213–229.

[5] Goldburg, R. and T. Triplett. 1997. Murky Waters: Environmental Effects of Aquaculture in the United States. Environmental Defense Fund, New York NY

- University of Maine, *Farming the Sea: https://science360.gov/obj/video/ae3d54f0-eb7e-4b0d-9db8-379be48f7b04/farming-sea*
- Soy Aquaculture Alliance, *The Working Waterfront—American Aquaculture in the 21st Century: https://www.youtube.com/watch?v=aGgtS4v9WBM.*

Senator NELSON. May I just ask, Mr. Kent, are you headquartered at Melbourne Beach?

Mr. KENT. Our—we have our laboratory—one of our laboratories at Melbourne Beach and another laboratory in San Diego. So we operate on both coasts of the United States.

Senator BLUNT [presiding]. I thank all of you for your testimony. We will start our 5-minute round of questions.

And, Senator Klobuchar, if you want to start that, that will be great.

STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Thank you, Senator Blunt, you and the Chairman, and Senator Nelson.

Minnesota is into fishing, as you probably know. We're the land of 10,000 lakes. One of our TV stations for the Super Bowl that's going to come to Minnesota has actually installed an ice fishing hole on the roof, and people are going up there and ice fishing in 5 degree weather.

So my question is about aquaculture, though, because we also have some exciting developments there. Cargill Aqua Nutrition is a leader in supplying sustainable nutrition solutions for aquaculture farmers. But we also have a company called Tru Shrimp that is currently developing some jobs in southwestern Minnesota. I actually just visited them this past summer, and they're going to break ground on a $50 million facility that will produce 9 million pounds of shrimp annually right near the South Dakota border actually, and this is in Luverne, Minnesota.

And, Mr. Lucas, can you talk about the role of a reliable water source? Dr. Lucas, I'm sorry, could you please describe that? Because one of the reasons they could locate down there is we've got this Lewis and Clark water project going with the Federal Government, South Dakota, Minnesota, and Iowa.

Dr. LUCAS. Yes, thank you. So our center also employs recirculating aquaculture technology. And the great thing about these land-based recirculating systems is they can locate pretty much anywhere. And the use of the recirculating systems to salt the water artificially, and you flow the water through the systems. So you're able to mechanically filter and biologically filter as well as sterilize the water so that you can reuse it. So it makes the use of water very efficient. And so they're able to produce. And so the great thing is you can be really close to your market supply. And these facilities can locate anywhere and be part of the chain and help provide local, safe, sustainable seafood to their consumers.

Senator KLOBUCHAR. Right, exactly. And do you see, Dr. Lucas, maybe Mr. Kent, just what are some of the obstacles—water is one of them—if you're in a location like our company is, but we fixed that, other obstacles to going forward with this?

Dr. LUCAS. Yes, ma'am. I think, like I said, the ability to be able to use the artificial seawater is great. I think the other thing is

consumer education, making sure people know that there is a domestically produced seafood product, that it's local, that it came from their environment, that it helped create jobs in their environment. So I think education is also critical to getting people to understand that this is helping support their local working population as well as provide them with some sustainable seafood product that is very healthy.

So in terms of land use, being able to do something similar, which is on a recirculating basis, or using the same water and using it, you know, even if you discharge water to grow plants or something like that, is very beneficial.

Senator KLOBUCHAR. Thank you.

Do you want to add anything, Mr. Kent?

Mr. KENT. Well, certainly. I think there's a wide range of technologies that can be brought to bear in developing aquaculture. We use recirculation in our hatchery operations. And, as Dr. Lucas suggested, being close to market is critical in producing the product right now. Importing so much of our seafood means that there's a huge cost in bringing that product in.

Senator KLOBUCHAR. Exactly.

Mr. KENT. At the same time, if we have recirculation going on in some areas, we can also have open ocean farming going. We have 37 million people in California, quite a few people in Florida. In fact, 70 percent of the world's population lives within the coastal zone around the world. So being able to utilize the ocean in combination recirculating technology means that we can get product closer to market, cutting the cost of producing that as well as reducing the energy requirements in transporting that product around the world.

Senator KLOBUCHAR. Thank you. I mentioned Cargill Aqua Nutrition with aqua feed, but, Mr. Luecke, we also will see some big benefit for grain farmers. What types of benefits would they potentially see from further development of the inland aquaculture? I keep emphasizing "inland," because of where my state is, like Missouri. Yes.

Mr. LUECKE. Yes, no, thank you, Senator Klobuchar. And consistent with what Dr. Lucas and Mr. Kent were saying, I think transportation is an important topic, and we're excited to be about 60 miles to the west of Tru Shrimp in Minnesota, so we're very excited about the project that they have. We hope to be providing feed to them at some point.

And so regarding transportation, being able—in Minnesota, the State of Minnesota produces a lot of soybeans as well. So being able to take soybeans out of our farmers' fields, process them locally, and then quickly move them into a value-added product like a fish or a shrimp is absolutely critical because we're reducing transportation costs all the way through the value chain.

Senator KLOBUCHAR. Exactly. And is soybeans something like 45 percent of shrimps' diet, is that right?

Mr. KENT. It's close to 45 percent.

Senator KLOBUCHAR. Yes.

Mr. KENT. And, you know, interestingly, what the other panelists have talked about is the use of forage fish or fishmeal as the primary protein source. And what our process has done is we've taken

soybean meal and taken the allergenic proteins and the allergenic sugars out of soybean meal, increased the protein level to 70 percent, which is what shrimp and fish want nutritionally. So having a technology that comes out of a land-grant university being commercialized, scaled up, and then being applied to companies like Tru Shrimp is a great opportunity for agriculture and for aquaculture.

Senator KLOBUCHAR. Mm-hmm. And with the low commodity prices right now, I think it would just be really helpful for soybeans and really all grains if this could move forward.

Mr. KENT. It's adding value to the crops coming out of the farmer's field.

Senator KLOBUCHAR. OK. Well, thank you. Well, maybe I'll see you there next time I visit.

Mr. KENT. I look forward to it.

Senator KLOBUCHAR. Thank you.

STATEMENT OF HON. ROY BLUNT,
U.S. SENATOR FROM MISSOURI

Senator BLUNT. Thank you, Senator Klobuchar. I was wondering how long it would take Senator Klobuchar to mention the Super Bowl.

[Laughter.]

Senator KLOBUCHAR. Ah, well, we keep mentioning that even though the Vikings aren't in it, and we are now going to be hosts to the Philadelphia fans. Not too easy for us after that game.

Senator BLUNT. There you go. It took 11 seconds, by the way.

[Laughter.]

Senator BLUNT. And not bad time on task, 11 seconds to get there.

On this topic, with what's going to happen with world food demand, the incredible change in what it's going to take to feed people over the next 25 or 30 years, I think the generally accepted estimate is that world food demand doubles between now and 2050, on the topic of just hatching to table, I think aquaculture either recirculating or on the coast, is about as quick as anything, but a little more information on that would be helpful. How quick does this process move along with the kind of product that Mr. Seaver and others who are preparing that product would want to have, that families would want to have? This is a pretty efficient process, I think.

Mr. Kent, do you want to start talking about that a little bit?

Mr. KENT. Certainly. The estimate is something like 400 to 500 million metric tons of protein more required than what we have now.

Senator BLUNT. Mm-hmm. And this is 33 years from now.

Mr. KENT. Yes.

Senator BLUNT. Growing every year between now and then.

Mr. KENT. What's been interesting is back in the eighties, about a third of our protein was coming from the ocean globally, but only a small percentage of that was aquaculture. Now it's still about 30 percent, but it's half and half. And if we try to get the makeup of the protein, that difference, that, say, 300 more million metric tons, the effect on the terrestrial side of things is going to be dramatic.

Beef, cattle, chicken: I mean, these are all important protein sources, but they're far more requiring of resources to grow, water. I live in the largest agricultural state in the Nation, we do $45 billion a year, and 80 percent of our water goes to food production. And when we have a drought like we had over the last few years, we lose 10 percent of our productivity. So having the ocean available, or recirculation, means that we become independent of what's going on in the terrestrial environment.

Also, these animals are inherently more efficient. The food conversion efficiency for a white sea bass or a yellowtail, some of the species we work with, is about 1.5:1. The protein gets converted much more efficiently from the food source into making protein. The primary reason for that is these animals aren't fighting gravity, they are floating in the environment, they are cold-blooded, so they're not maintaining body temperature. And also, as far as space goes, you can stack them in a cage the way you can't stack cows. So it is a much more efficient process. And utilizing the ocean means that we're not—we don't have to have the land or the fresh water to grow some of these species.

Senator BLUNT. And I don't think I have an answer. Give me an example of one or more of the species you like to work with.

Mr. KENT. Key species we like to work with is California yellowtail. It's imported for the sushi trade, for hamachi. All the hamachi in the U.S. is farmed in Japan.

Senator BLUNT. And you start with a hatchling?

Mr. KENT. We start with adult fish weighing 30, 40 pounds. We get eggs that are about a tenth of a millimeter—or, excuse me, a tenth of an inch in diameter. We will harvest about 120,000 1-gram fish out of an 8-foot pool after 60 days. Those fish will weigh 30 grams in another 30 days, and they'll grow to a marketable size of 4 to 5 kilos in 18 to 20 months, depending on ocean temperature. So that may not compare to how fast you can grow a cow, but it required a lot less food to get you there.

Senator BLUNT. Mm-hmm. And on the non-saltwater species, the catfish, the tilapia, how do those numbers compare, Dr. Lucas?

Dr. LUCAS. I am marine species by trade, so I can't really speak to the freshwater species and information.

Senator BLUNT. Mm-hmm. Can you, Mr. Luecke?

Mr. LUECKE. Yes, Senator Blunt. They're faster than marine species. They grow to a smaller size, you know, so 4 to 5 pounds, typically 6, 8 months, you know, for a medium-size trout or slightly faster for tilapia.

Senator BLUNT. Six to 8 months?

Mr. LUECKE. Mm-hmm.

Senator BLUNT. Mm-hmm.

Mr. LUECKE. And I think, you know, one of the important things to think about when you think about both the water supply and the sustainability of, you know, the nutritional process, we're looking at, as Mr. Kent mentioned, the entire nutritional value chain. So how efficient are we converting one protein to another?

So we look at the digestibility of the ingredients. So we want to make sure that the ingredients that we're feeding to any type of fish, whether it's freshwater or marine species, are very digestible. So we look at how digestible the protein that we're feeding them

is. For example, fishmeal, which is a less sustainable ingredient, is about 85 to 90 percent digestible. Our soy product is 100 percent digestible. And what that means is that the animal is using that ingredient much more efficiently.

And then back to Mr. Kent's comments, that animal, the fish, can actually convert that into a fish filet on a 1:1 for 1.5:1 basis. So it's a very efficient process when you look at the digestibility of the ingredient.

Now, one other factor with the digestibility of ingredients is that you get a much cleaner water if the ingredient is digested. For example, the phosphorus in soybean meal or in fishmeal is—without other processing, is not fully digested by the animal. So when you're feeding fishmeal, about 50 percent of the phosphorus goes into the surrounding environment. When you feed an advanced soy protein, 100 percent of the phosphorus is being digested, so you're not discharging that into the environment. So the digestibility of nutrients is absolutely critical to the growth of the fish.

Senator BLUNT. And, Mr. Seaver, how about just generally the digestibility of the fish? I mean, how would fish, as we're thinking about this, as a protein source both mix in with the other protein sources available to you, as an entrepreneur and to people who are consuming, and what advantage do you get when that fish is close rather than further away?

Mr. SEAVER. Well, there are a number—thank you for the question. There are a number of benefits, physically speaking, from the public health side. Diversity in our diet is not what it should be in terms of our protein consumption, and beginning to not necessarily reduce—well, there's an opportunity really to radically increase the amount of seafood that we consume, and I think that especially when it comes to the local opportunities, as Senator Klobuchar was speaking to, there is really a lot of opportunity to create a narrative around seafood, that this is produced locally, this is shrimp from Minnesota, gets attention on a menu, it gets that menu item to sing, it gets it onto the table. And so there are the efficiencies there that Mr. Kent spoke to about in terms of the energy efficiencies.

But then also we've been speaking largely around finfish, but there is also the opportunity to look at marine shellfish production, and especially when we speak to oysters, clams, mussels, scallops—no offense to the soybean farmers of America—but those things feed themselves completely, and while I very much support all these efforts as well, I think we need to be looking at the farming of shellfish varieties as truly just a magnificent opportunity as they, in fact, improve the quality of water in which they are grown.

And they also are—while we are speaking here about large-scale opportunities and large-scale investment that's needed to go offshore, when you're speaking about nearshore and inshore aquaculture, we're also sort of inherently speaking about the primacy of the small farmer owner/operator and the great narrative that is there, the job creation that is there. And so when we talk about a mussel that can be seeded, attached to a rope, put out into the environment, it feeds itself, and in 12 to 18 months be ready for the table, this is a commendable opportunity and something I think that we should be really supporting full-fledged.

Senator BLUNT. And I think there is some concern. I don't know who on the panel might be in a position to talk about this, but some concern about seafood that is farmed rather than wild caught and where it was and how it was grown. And I think there would be reasons that Americans would like to think that that seafood had come from a place, or fish of any kind, come from a place that they had a greater sense of supervision and regulation. We occasionally hear on fish issues that, well, a lot of people got a product that didn't turn out to be a very good product. What would be the benefits of more U.S.-grown seafood?

Mr. Kent?

Mr. KENT. Well, living within the regulatory framework for how all of our food is produced, meets a very high standard. When you're importing so much of your seafood from somewhere else, how do you know how it was grown? I'm not suggesting that it wasn't grown properly, I'm just saying it's very hard to know whether it has been or not. And even sometimes the origin gets confused. Even the species of what you're consuming can be confused. But if it's coming from a farm in your backyard through recirculation, or out in the ocean and coming back into the dock, and you're permitted to grow a given species in a certain way following USDA and FDA standards, then you have a lot more reliability on the idea that, well, that fish was grown according to the way we want it grown. And there are even ways to put traceability into it, where you can actually go into the market and put a little code that's called the Q——

Mr. SEAVER. QR codes.

Mr. KENT.—QR code and flash and know when that fish was spawned or when the hatch occurred and when it was harvested and when it went on ice and when it went into the store. That can all be done by the consumer now, which is very difficult to do if you're unloading a freighter full of frozen fish coming from Taiwan, but it's something we can do very readily in our own farming capabilities here in this country.

Senator BLUNT. And one last question from me for I think Dr. Lucas and Mr. Kent. What could the Congress do to help create the kind of access that you need to the coast or anything we can do to eliminate obstacles you're finding in aquaculture generally? But I think particularly the Federal issue here may be a coastal issue.

And, Dr. Lucas, why don't you start, and then Mr. Kent, and then we'll go to Senator Fischer.

Dr. LUCAS. We have to look at ways to reduce the barriers to entry. Businesses need certainty. The permitting is going to be key. They need a defined permitting process. They need to know the backbone or structure of the permitting that can occur, and that can be regionalized in some aspects, but they need to know that one agency is in charge. They don't need to run around to five different agencies who nobody takes ownership. They need somebody to have ownership, and they need to get that through designating an agency.

They need to also know that their lease or that their permit is going to be of a long enough duration that they can not only capitalize those expenses that went into getting the operation up and running, but that they can also see a return on investment and a

profit. And if they're good actors, and trust me, they want to be good actors. They want to follow all the rules and all the regulations, and they want others that are in the industry to follow those regulations, so they're looking for that level of enforcement. But, they want to know if they follow those rules and those regulations, that they are going to be able to get a renewed permit, that it's almost pretty much certain. They want those level of certainties to help reduce the risk.

In addition to that, we need to continue to work with academics and governments to decrease some of the things that are barriers in terms of production. Businesses often come to us in regards to larval culture or hatchery techniques, helping to reduce some of the uncertainty there and reduce the bottlenecks that occur in the hatchery. They need a safe, disease-free larval fish. Some companies will put that into their vertical integration, they may put the hatchery as part of their plan. Others may just purchase from a hatchery.

The other things they come to us about is in regard to selective breeding. Universities tend to have access to a lot of equipment in terms of being able to look at the genes of fish and help determine which fish are going to be more successful in aquaculture. And so using those tools as well as disease management, those are things that industry often comes to a university to help them with and to overcome those barriers as well as continuing to expand the nutrition and look at reducing our reliance on the reduction fishery for products. And, of course, advanced technology, which I think will continue, continue to grow.

Senator BLUNT. OK. Mr. Kent, Federal obstacles that we can do something about.

Mr. KENT. Well, wearing my—I'm trying to get a permit hat right now, I'd say that the biggest thing that we need is a process that's defined. And as I mentioned, I don't think it's really the legal permits that are required, the Section 10 or the NPDS permit that are a limitation, because the agencies in charge of those understand what their authorities are.

It's really the NEPA, the National Environmental Protection Act, certification that needs to be done. That needs to be led by an organization, a Federal agency, that has the broad scope of understanding of environmental concerns that people have and how to mitigate or eliminate those. And in my mind, that has to be the NOAA fisheries.

NOAA has the—when you talk about habitat, interference with other fishing operations, endangered species, these are all consultations that have to be performed with NOAA anyway, so why not put them in the authority? They have not only the research, but the regulatory experience, to deal with these issues. And if there is something that the legislature could do, it might be to mandate that through legislation to bring forward a law that said NOAA is the lead agency.

From putting on my researcher hat, the first thing we need is an industry. Dr. Lucas' team, our team, we're ready to solve problems, but we need an industry that needs these problems solved, and until we have more aquaculture, we can be working on new diets, we can work on species that need to be domesticated, and we can

work on disease treatments, but until we're actually going to have an industry that uses it, we're kind of just spending your money and not really getting us any return on the investment. So we need to start an industry that then the scientific community can rally behind and help support in cooperation with the agencies, the USDA, NOAA, all the different organizations that recognize needs, and science can come and help solve the problems.

Senator BLUNT. Well, Senator Klobuchar, Senator Thune, and I are pretty interested in that industry being also inland and close to those consumers, but I think this is an important part of the solution we need for the opportunity and the challenge we're about to face. And I want to thank you for your time today.

Senator Thune.

The CHAIRMAN [presiding]. Thank you. Thank you, Senator Blunt. And again thanks to our panel, and I appreciate very much you being here and sharing your thoughts about what we can do to do a better job of growing this economy, growing this business, in our country.

And thank you, Senator Klobuchar, having worked to authorize the Lewis and Clark Rural Water Program during my time in the House of Representatives, a long history of supporting this important project. And Tru Shrimp's story shows what's possible when this country has a solid infrastructure backbone. So it's quite a testament to American hard work and ingenuity, when "Minnesota-grown" includes shrimp, right?

[Laughter.]

The CHAIRMAN. Well, we've got the Vikings, we've got to have shrimp, so . . .

[Laughter.]

The CHAIRMAN. Sorry. I know, I brought it up. That's——

Senator KLOBUCHAR. We already talked about it.

The CHAIRMAN. Yes.

[Laughter.]

Senator BLUNT. It took Senator Klobuchar 11 seconds to mention the Super Bowl. It took you 23 seconds.

The CHAIRMAN. Oh, did she really get into it?

[Laughter.]

Senator KLOBUCHAR. Yes, but Senator Thune does have the Corn Palace.

[Laughter.]

The CHAIRMAN. Ooh, careful, easy.

[Laughter.]

The CHAIRMAN. It's our pride and joy.

So, Mr. Luecke, as you well know, and I know you talked about this, South Dakota soy is some of the best in the world, and it's used in many products. Some may be surprised to hear that the so-called square states, like ours, have an important role to play in fish farming. So could you kind of just tell us how your new commercial-scale facility impacts the local economy in South Dakota?

Mr. LUECKE. Absolutely. Thank you, Senator Thune. And the square states do have an important role to play in aquaculture because right now for aquaculture producers that are trying to get started in the United States, the high-quality feed ingredients that they depend on, they're coming from foreign countries like Peru

and Chili and even Southeast Asia. The forage fish that we've talked about are what is used in the diets of aquaculture species, and that transportation cost to get the high-quality feed ingredients into the United States for aquaculture production is cost prohibitive. And so producers are losing a significant amount of money to their bottom line.

And so what we're doing with our process and, again, our process is taking soybean meal, which is a co-product of soy processing, we get soy oil and we get soybean meal, and we're taking some of the things that fish don't like to eat—the allergenic proteins, the allergenic sugars—we're taking that out of the soybean meal and really making it look like, from a protein ingredient standpoint, the very feed ingredient that aquaculture producers are accustomed to feeding the forage fish. It's a 70 percent protein, very highly digestible.

So once we can bring that high-quality feed ingredient domestically, we can provide that from the heartland, then we should be able to grow more aquaculture facilities because we're not depending on importing the very feed ingredients that we're dependent on to start this industry.

So we feel like we've got an important role to play. We feel like soy has a very important role to play. It's a sustainable product. It has a high amino acid digestibility. And it's good for the environment, it's not discharging phosphorus into, whether it's a recirculating system or a marine environment. So we do, we feel like we've got a very important role to play.

The CHAIRMAN. So what would be the economic impact on soy-growing states if the United States were to embrace domestic aquaculture?

Mr. KENT. Well, it's significant, Senator Thune, because the—right now, you know, we're feeding a lot of soybean meal to livestock, and as we've talked about on the panel, the feed conversion ratio of that is—it's not as efficient as aquaculture. So for a soybean farmer that's looking for higher value uses of its soybean meal, aquaculture is a perfect example. Today, soybean meal trades for about $300 a ton whereas fishmeal trades for between $1,500 and $1,600 per ton. So there's a significant spread between those two high-quality ingredients, and it's something that our soybean farmers can actually take advantage of the marketplace.

Now, you know as well as I do, when the farmers do well in the fields, they're spending that money locally, and so not only do family farm incomes increase because we found higher value uses of a commodity, but the rural communities around them, just like the coastal communities, when aquaculture thrives in a marine environment, those rural communities thrive because the farmers are buying new pickup trucks, they're spending money at their local grocers, and that money gets recirculated in rural economies.

And so, again, it's a very high impact, and it's not just the farmer that's seeing the impact, it's really the rural communities around them.

The CHAIRMAN. The critics of aquaculture point to the use of fishmeal as feed to suggest that aquaculture is a zero-sum game. In other words, by increasing aquaculture, you're decreasing the amount of wild-caught fish available. How does using soy-based feed change the impact of aquaculture on our wild-caught fisheries?

Mr. LUECKE. And that's one of the biggest problems that we're trying to solve, Senator Thune. And, again, I think everybody on the panel can agree that nutrition is a key element. And so you want to make sure that you have high-quality ingredients that are going into aquaculture production and you have a very efficient process. We've shown that we can use soy to replace or extend the use of fishmeal in diets up to 100 percent. So, again, not only are you not in that zero-sum game of fish in and fish out, which is what the industry uses, but the retail channel is also looking very closely about the traceability of the ingredients that are going into fish production.

So, for example, the retail channel wants to know that because a fish is almost a 1:1 basis for what it's eating to what is being produced on the shelf, they want to know where the ingredients came from, and when you can trace that back to the farm, which we can do, they get much more comfortable in the product that they're putting out onto the shelf.

And the other thing that we mentioned previously on the panel is the fact that when you're feeding forage fish, not only is it a zero-sum game, but there are also a lot of things in forage fish, like phosphorus, that's not being completely digested by the animal. So one of the things that we have to be very careful of, as stewards of our environment, we have to be very careful about the nutrients that are fed and not digested. And so with forage fish, 50 percent of the phosphorus is not being used by the animal, it's being discharged into the environment, and that's harmful. So soy helps all of those things and really gives us a step up. It creates a much, much cleaner image for aquaculture.

The CHAIRMAN. Dr. Lucas, the regulatory barriers to offshore aquaculture in the United States seem to be a textbook example of how regulatory burdens can stifle economic innovation. Could you talk a little bit more about the barriers to a healthy aquaculture industry in the United States and any suggestions that you might have to alleviate those?

Dr. LUCAS. Yes. So we discussed a little bit earlier about trying to make sure we have regulatory certainty, that somebody takes ownership of kind of the permit process. I think that's something that this—that Congress could do through legislation, designating that person who is going to take ownership of it, work through the NEPA process, work through the environmental process. I think that's going to be critical to helping industry move forward. They want some certainty that at the end of all the money and all the hard work that they put into finding a site, that they are going to be able to get a permit and that the permit and the lease duration is going to be long enough to not only see a return on their investment, but to also see them be able to profit from their investment.

They also want to be good actors and want to have the enforcement element piece. They want to know that if they follow all the rules and regulations and the monitoring requirements, that they will have reasonable certainty that they can renew that permit that they've been working on. And I think those will be critical moving forward for industry. In addition, working with industry and developing industry, we are developing an industry, and what it looks like on day one will be a lot different than what it looks

like at year 10 or year 20 and the advancements that we make. And some of those things are through research.

I think Congress and legislation and appropriations that are on the scale of what we did with the agricultural industry is critical. We used the agricultural industry and we used academia and Federal and State labs to do the research and then do the extension, you know, across the Nation to help farmers grow. I think the same thing can be done in aquaculture. You can use the same kind of pattern of competitive-based research and extension funding and those long-term fundings to actually get that technology out to the industry and to work with industry.

I think public-private partnerships will be critical to helping the industry advance. And I think that funding along those lines for things that are the barriers in terms of being able to do marine species offshore will be critical to industry developing.

The CHAIRMAN. Thank you.

Senator Hassan.

STATEMENT OF HON. MAGGIE HASSAN,
U.S. SENATOR FROM NEW HAMPSHIRE

Senator HASSAN. Thank you, Mr. Chair.

And good morning to the panel. Thank you all for being here.

Aquaculture has brought my State of New Hampshire a new support system to the local seafood industry. In New Hampshire, our Sea Grant Program and the University of New Hampshire have been working with the Portsmouth Commercial Fishermen's Association to farm steelhead trout, mussels, and sugar kelp in floating pens on the Piscataqua River, and it has been a terrific partnership between the state's Sea Grant Program and the university. It has allowed both teams of experts to help train local fishermen in the basics of aquaculture, which include feeding, maintenance, harvesting, and packaging the products for sale.

So my question is to you, Mr. Kent. How else can aquaculture be integrated with the existing harvesting and processing sectors of the fishing industry? And do you believe fishermen can transfer their existing skills to other sectors in the aquaculture industry?

Mr. KENT. Certainly. I've been approached by commercial fishermen that have—are third- and fourth-generation fishermen, and they're going—like my dad fished, I fish, but son is not going to be able to do this.

Senator HASSAN. Right.

Mr. KENT. And they're looking at, as Mr. Seaver was talking about earlier, this idea that we have a culture of being on the sea and providing product and bringing it back to the dock. The big difference is you're not going to go out and have to find it, it's sitting right there, you know, at the farm——

Senator HASSAN. Right.

Mr. KENT.—and you can harvest it on demand.

And the other important factor is the idea that for every job in the fishing boat or on the farm, there are two, two and one-half jobs downstream to keep that industry going: the processing of the fish, the distribution, the maintenance of the boats, the nets, and everything else. So it really increases the profitability of the working waterfront. And, you know, I'm from San Diego, we were the

tuna capital of the world, and now our waterfront is made up of Hyatt Regency Hotels and maritime museums.

Senator HASSAN. Right.

Mr. KENT. Our working waterfront has been reduced down to very small areas that there's heavy competition for putting luxury yachts in there instead of fishing boats.

Senator HASSAN. Right.

Mr. KENT. So having product coming in means these ports have the capacity to say, oh, this is an income stream now that we need to maintain, and we need to have the infrastructure in place.

Senator HASSAN. That is very helpful and I think something that the fishermen in my community—you know, New Hampshire's coastline is relatively short, but it is very vibrant, and we're trying to keep it that way.

Mr. KENT. Well, something to keep in mind is my guys sit at microscopes.

Senator HASSAN. Yes.

Mr. KENT. They're not going to go out pulling nets. We need the skill set of guys that can work in a 10-, 12-foot sea, bringing product in, and working, maneuvering boats out there in the ocean. So that's really the people we're turning to, to run these farms.

Senator HASSAN. OK. That is very helpful. And I guess the other question I have for you is around environmental quality. How can we maintain environmental quality and strengthen it while providing the industry with this kind of flexibility it needs to develop in offshore areas?

Mr. KENT. I think it's really about the location.

Senator HASSAN. Yes.

Mr. KENT. If you pick the right site where you're not interfering with other operations and you have the right depth and the right current flow, the presence of the farm is undetectable.

Senator HASSAN. Yes.

Mr. KENT. And that has been shown in lots of circumstances. And that's a hard lesson that the salmon industry in Chili had to learn, that a lot of other industries or a lot of other aquaculture industries in other parts of the world have had to learn, is that if you pollute the environment that you're growing your fish in, you're causing yourself problems.

Senator HASSAN. Right. Yes.

Mr. KENT. And so picking the site is critical. And so we've been working with NOAA on doing that as well for our proposed farm.

Senator HASSAN. Well, thank you very much.

That's all the questions I had, Mr. Chair.

The CHAIRMAN. Thank you, Senator Hassan.

Senator Klobuchar, anything else?

Senator KLOBUCHAR. No. I'm all done. I really learned a lot, and I'm excited about what you're doing. Thank you.

The CHAIRMAN. Let me ask a question, and anybody on the panel can respond to it. But your testimonies highlight the economic, environmental, global security and health benefits of increasing domestic aquaculture. However, there is still a perception that farm fish is somehow bad or less desirable than other seafood. So what is your response to some of those perceptions?

Dr. Kent, and then we'll just go across.

Mr. KENT. Well, the reality is half of the world's supply is farm now, and so it's if you don't like the idea of farm fish, then don't eat it, the next guy will. I mean, that's just flat out the reality of it. In fact, what's so problematic with that attitude is really if you grow fish correctly, if you grow shellfish correctly, you have far more control over the quality. You don't have to harvest it until Mr. Seaver wants it. On Tuesday, he goes to put a ton of yellowtail on the dock; Monday, he will go out to get it; Tuesday morning it will be on the dock for him. It's not going to get any fresher than that. And so control over the supply chain is critical in that. Knowing how it's grown, as we were discussing earlier, is critical in that.

And we've taken our fish and provided it to some of the most discriminating chefs around, and they feel it's some of the best product they've ever worked with. In fact, the head chef for the Hyatt Regency said that fish that we provided him was better than anything else he could buy in the market. He'd like to make it a signature dish at all the Hyatt Regencies around the world. So that speaks to the quality of how the fish can be harvested and grown and provided to the consumer.

The CHAIRMAN. Thanks.

Mr. SEAVER. Thank you for that question. Unfortunately, I think seafood across the board suffers from the stigma of being somehow a lesser protein. In fact, I believe that seafood is the only protein that we eat that's considered guilty before proven innocent, whether it be the quality of the wholesomeness—I've never asked, "Is that pork fresh?" But I hear that asked. You know, the quality of seafood is contended from the minute we decide that we would like seafood if we are going to enjoy it at all. And unfortunately, through environmental conversation as well as through just cultural conversation, farmed seafood and wild seafood have been put into alternate categories, but really they are the same thing. They are the source of the healthiest animal protein that we can eat as people, and the source of the most sustainable seafood and the most sustainable animal protein that we can produce as a nation.

And so I think that there is a—unfortunately, an illegitimate barrier to separating seafood from farmed seafood from wild seafood that we need to address first and foremost. And I think once that happens, once we begin to elevate seafood categorically using whatever means we might have to do it, whether it is the story of local shrimp in Minnesota at the Super Bowl, whether it is soy and the opportunities that creates, or whether it is just public health, I think using those opportunities, those angles of leverage, to elevate seafood as a aspirational protein in our nation is going to be—is going to have a major effect on reducing that stigma and beginning to allow opportunity for the industry that Mr. Kent spoke so eloquently about, that Dr. Lucas has spoken so eloquently about, allow for that industry to thrive and to grow.

The CHAIRMAN. And how does the restaurant industry, how do people like yourself, chefs, get the message out about the health and qualitative advantages of seafood relative to other forms of protein?

Mr. SEAVER. Quite honestly, unfortunately, a lot of us spend our time combating negative messaging, and there is so much misperception and negative messaging around seafood, and part of

this is that there has not been a very concerted effort to go pro-seafood information. It is a very fractured industry unfortunately as we look at when we're talking about imports, exports, the domestically produced, farmed, wild, even the seafood industry internally doesn't necessarily always have a positive narrative about itself. And so when we combat, when we try and talk about seafood, unfortunately we're oftentimes dismissing the negatives.

And having the opportunity, especially with colleges and universities, which offer the opportunity to really engage, and you were saying the state extension programs and using the academia. Well, hey, let's use the whole campus of academia as a methodology, as a means, to really increase the presence of seafood in our dialogue, cultural dialogue. And these are also state institutions that have massive purchasing power that maybe likely won't be producing or using very high-end products, but certainly can provide opportunity I think to invest in and be sort of the building block contractors for the seafood being produced. Thank you.

The CHAIRMAN. Great. All right.

Senator Blumenthal.

STATEMENT OF HON. RICHARD BLUMENTHAL, U.S. SENATOR FROM CONNECTICUT

Senator BLUMENTHAL. Thanks, Mr. Chairman.

And thank you all for being here and for your excellent testimony. Connecticut has a long and historic involvement in shellfish and aquaculture and generally the commitment to the environmental treasures that are reflected in this important work. And so I would like to begin by asking you about the potential dangers of offshore drilling to aquaculture and the kinds of interests it represents. Are you concerned with offshore drilling as a potential danger?

Mr. KENT. We actually have in Santa Barbara, California, we have an offshore farm that's growing mussels, and Santa Barbara is probably the center of our oil industry in California. Certainly, a leak, a spill, or something would have a devastating effect on a farm. At the same time, the increased infrastructure in the ports that support offshore drilling can be supportive of aquaculture as well. When we originally were proposing a farm, it was off the coast of Ventura, and they spotted the dock where the crew boats leave to go out to the platforms was right—was the same dock that the commercial fishermen offload their product at. So having that working waterfront is extremely valuable. That aside, I don't—other than the concerns about leakage or spills or something, I don't see that they're mutually exclusive.

Dr. LUCAS. Being from the Gulf of Mexico, we have a relationship with our oil industry. And so I speak to the same thing that Mr. Kent spoke to in terms of having the infrastructure that's already in place. Also, I know several of the investors have reached out to some of the oil companies that may be decommissioning rigs for the potential to use those rigs as a station in which they can house people, fly in product and stuff, and have their farm far enough away that that's an easier access. Deep water in the Gulf of Mexico is not found right offshore, we have to go a good ways, and so looking for those logistics has been important.

So other than the things that Mr. Kent has spoke to, we understand that there is a greater good for energy producing as well as there is a greater good for reducing the seafood trade deficit through aquaculture production.

Senator BLUMENTHAL. Let me ask you about the budget that we've received from the administration, which cuts back on a number of programs that I think are important to aquaculture; for example, the NOAA Sea Grant Program. Is that kind of program important to you?

Dr. LUCAS. That kind of program is very important to us. In terms of how you see the agricultural industry using land-grant institutions for extension services and getting those products out to farmers, the same thing is true of Sea Grant. They work with industry and they work with academics to bridge that gap. So they are able to work with the academics and partner with the industry to work on what industry needs and then transfer that technology over. So they are our extension, and that is very critical to helping us advance aquaculture. They have been a huge player in helping with aquaculture technology.

Mr. SEAVER. If I may briefly speak to that as well, Sea Grants are inherently attached to and very close to the next generation that's coming up. And in my home state of Maine, this is a very big deal that aquaculture presents the opportunity of innovation, of excitement, for that young son or daughter to stay in their community, to combat the brain drain of rural coastal communities, and to begin to rebuild the vibrancy and heritage of those areas, and that slightly less tangible result of that Sea Grant impact, but——

Senator BLUMENTHAL. It's still important.

Mr. SEAVER.—it's very intangible on the community. Thank you.

Mr. KENT. Just on a personal note, as a former Sea Grant trainee, I think it's a hell of a good program and certainly helped me with my career and got me introduced immediately from the academic sector right into the research field, and I think that's critical, is giving students that experience and set them on the course to the practical side of science.

Senator BLUMENTHAL. Let me just close because my time is limited by saying that there are—and I appreciate that perspective on Sea Grant. Another Federal program is the Seafood Import Monitoring Program that establishes reporting and recordkeeping requirements for certain kinds of fish so as to make sure of their origin. The program unfortunately applies only to 13 species. So much of the world's seafood comes from sources that could be misrepresented or mislabeled. I've worked with a number of my colleagues on this issue, including Senator Wicker, from Mississippi, whom you no doubt know. And I'm hopeful that we can expand this program.

In the meantime, domestic aquaculture could overcome some of these issues, I think, and ensuring confidence in the origins and integrity of our seafood supplies. So I hope that this point will be emphasized as well, and I'm assuming that all of our panelists would agree with that point today. And I'm not going to overstay my time, but thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Blumenthal.

Senator Cantwell.

STATEMENT OF HON. MARIA CANTWELL,
U.S. SENATOR FROM WASHINGTON

Senator CANTWELL. Thank you, Mr. Chairman.

Mr. Seaver, thank you and all the panelists for being here. Bristol Bay supports about 20,000 jobs in commercial and recreational fisheries and as well as restaurants, which I'm guessing you're here to represent. Recently, the EPA announced they would not withdraw the proposed determination under the Clean Water Act. However, they are not finalizing it either, so it's a question about what remains and what they will do.

How important is Bristol Bay salmon to the restaurant industry?

Mr. SEAVER. Bristol Bay salmon and all that it represents—the jobs, the culture, the heritage, the communities, that is the—those are the very basic underpinnings of what restaurants serve both in terms of what we give, but also who we serve.

Bristol Bay salmon specifically is—you know, we have strategic oil reserves in this Nation. That is our strategic salmon reserve. That is our strategic food reserve. In fact, it is also our strategic example of how and why fisheries should be managed as we do. I don't think that there is—it's hard to say that one fishery is more important than another, but I think Bristol Bay sets the example of what all fisheries should be, and should be held up and preserved as an American icon in that way, and everything possible should be done to protect them—the fisheries—and those who fish them.

Senator CANTWELL. Thank you.

Mr. Kent, well, or in general to our panelists, so last August we had a pen holding more than 300,000 farmed Atlantic salmon that broke and released thousands of Atlantic salmon into the Salish Sea. So this caused very great concern to us because the wild Pacific salmon compete for resources and prey and obviously they can carry different diseases. So the negative impact on Pacific salmon is something that we just can't sit still for. So we need to do something.

The Federal response to the pen failure was very uncoordinated in the sense that this pen hadn't been examined since 1987. This partly falls under the jurisdiction of the Army Corps and partly under NOAA. We also just had a mussel issue in the Northwest, too.

So who owns the—particularly when it comes to this netting issue? If there had been an inspection in both of these cases, we might have determined something before. So I don't know who the best person to answer this is.

Mr. KENT. I don't know that I am, but I'll take a shot at it.

Senator CANTWELL. Yes. Thank you.

Mr. KENT. It was a very unfortunate occurrence that happened, and equipment has to be maintained, and maybe there is a little complacency that occurs within an industry that has been operating for 40 years and is using technology from back 40 years ago. Out in the open ocean, it's a much more rigorous environment, and the cages have to be inspected more often. You have moorings that are going down to 300 feet of depth, and that's something where a diver doesn't swim down there everyday, but remotely operated

robots can do that. And that would be part of what we're trying to do.

And more importantly than anything else, I know there has been a lot of statement about, well, the fish appear to be malnourished and they look like they're healthy enough and they didn't think there was going to be an adverse impact in some of the reports that I've seen, but the reality is, why are we trying to grow species that are not native to a given area in a new area? We should be growing Pacific salmon in the Pacific, white sea bass in California, red drum in the Gulf, and Atlantic salmon on the Atlantic coast. Let's grow the species that are appropriate and not move these things around.

Some California abalone farmers imported South African abalone one time to see if they could grow nicely in San Diego and ended up with a parasite, the sabellid worm, that not only spread through the farms, but it spread into the wild population. This is the kind of commonsense thing that really should be avoided, and, you know, trying to—I don't have a—I don't have a solution for how to deal with the Atlantic salmon issue in Puget Sound, but it's not the direction I would go in, in starting a farm. There are species in each region that should be grown in that region.

Senator CANTWELL. Nor would I. Nor would I.

Anybody else?

Dr. Lucas, did you want to mention something there?

Dr. LUCAS. I echo what Mr. Kent said. I'll also say that, you know, we've improved a lot of technologies now. I mean, the new materials that are coming out for some of these cages as well as the remote detection devices and stuff, industry needs to advance, like you said, and look at some of these things, especially for offshore. And I think that the intensive monitoring programs that go along with that can go a long way in helping to prevent an instance like you had.

Senator CANTWELL. Well, I'm definitely going to look in further to whether the Army Corps and NOAA need to play a stronger role in making sure that things are being inspected. We can't have something there since 1987 not being inspected. I guarantee you, protecting the wild Pacific coast salmon is something our country believes in, and we're going to fight to make sure that it is protected.

Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Cantwell.

Senator Sullivan.

STATEMENT OF HON. DAN SULLIVAN,
U.S. SENATOR FROM ALASKA

Senator SULLIVAN. Thank you, Mr. Chairman.

I appreciate the witnesses here. I appreciate Senator Cantwell's comments, all of which I agree with. And, Mr. Seaver, your comments on Bristol Bay salmon were also something that was music to my ears. You didn't add that farm-raised seafood doesn't even remotely compete with wild Alaska seafood, whether it's Bristol Bay salmon or otherwise, in terms of taste and texture. And I guarantee you if every single person in this room did a blind taste test,

it would be 100 percent for the wild Alaska salmon. But I know that's not what you're here to testify about.

[Laughter.]

Senator SULLIVAN. I think that's a fact, and maybe I can submit something for the record that makes it 100 percent clear.

But, you know, Mr. Kent, I actually want to follow up on what Senator Cantwell asked about the massive Atlantic salmon escapement from an operation in Washington State, and, of course, that brought enormous concern to Alaskan fishermen in terms of the impacts on healthy stocks. And do you think there is something we can do? It does seem somewhat uncoordinated, but a policy perhaps, that you mentioned that just makes sense, hey, if there's a risk, and there is always going to be a risk, right? I mean, we want to minimize that risk certainly, but if there is a risk, does it make sense to kind of do this checkerboard approach to having species that have no business being any part of that world out in that part of the world when there's a risk? I mean, it seems to me that might be a policy area that we could pursue that might make sense. Right? Why do we want very foreign species in an area if there is a risk that you could see some kind of escapement that could cause damage and certainly cause worry to the fishermen who fish for the wild Alaska salmon or other wild Alaskan products?

Mr. KENT. It's a very good question. And I don't know exactly what agency would handle it. I go back to this concept of best management practices. My recommendation would be that in an open system that's out in the environment, that we ought to be growing the species that are native to that area. In a recirculating system, of course, you can grow something that, you know, in Minnesota we can grow a foreign species in an enclosed tank without much chance of that escaping and endangering endemic species in the area.

And then back to Mr. Seaver's point, I think it's also playing to the idea of the culture within a given area. If we're going to be growing species that are native to a certain area, there's a grouper in the Gulf, I mean there's this respect for that fish down there, salmon in the Pacific Northwest, cod in other parts of the country. White sea bass in San Diego, red drum in the Gulf. We have these existing fisheries that aren't in some cases able to produce enough of what we need. And building off of that market regionally I think is of benefit. There's no reason why we can't bring a red drum fillet into San Diego and enjoy it, or a white sea bass into Apalachicola, Florida, but at the same time, we don't want to grow them there. We want to grow them in our own regions.

Senator SULLIVAN. Let me ask kind of a related question. It's kind of a federalism, and, Dr. Lucas, maybe you can start by addressing it in a little bit of background. Since 1990, finfish aquaculture has been prohibited in Alaska's state waters. However, Alaska does choose to allow certain forms of aquaculture, such as salmon fishery enhancement through hatcheries and aquatic farming of shellfish and seaweeds. And in 2016, we created, in my state, the Alaska Mariculture Task Force to help accelerate development of mariculture.

But I think it begs a question: How can the Federal Government help coastal states, like mine, develop the types of aquaculture that

they choose to that have the support of the citizens, like some elements of mariculture, while also maintaining their right to choose what not to do? And this discussion kind of impacts that.

So there needs to be, in my view, a very healthy federalism component here about what a state and its citizens and its fishermen support. How can we do that better?

Dr. LUCAS. Well, to begin with, I know social license, that we call it, or industry, they are looking to go into an area where they're accepted. And that's part of going into an area where you're doing species that are already part of the heritage and already part of the culture and already are an important part of the community. The industry looks for things like that. They want to work with their local communities.

I think in the case of states, there are a couple of options for states that do have CZMA through consistency, that they could not allow certain species that weren't part of their state plans for states that don't have the CZMA. I think potentially doing some kind of opting program where you could opt out of, you know, species that you didn't—that your state doesn't wish to engage in, as long as there is some certainty there that—I mean, you can't just opt in 1 year and opt out. You want some kind of plan as to how those were chosen, and I do believe Alaska has a law that doesn't allow for the finfish aquaculture, so that would probably be something that would have to grow in support from the public before that law was even changed in your state to allow for it. You do have great shellfish work and even some of the seaweeds, the macroalgae, I've been working with some of the people from Alaska on that, and so I think that's great. But it's part of the social acceptance.

We, as a community, need to get out there and engage in the public in terms of what aquaculture really looks like because what they see—what they see is some of these farms from overseas, and these areas that don't have the robust environmental regulations that we have do not have the robust regulations for drugs, such as through the FDA, don't have the transparency that we have. And when people can see that transparency and they can see a video, like the QR codes we were talking about where you take a picture and you see the farmer out there working on their farm and bringing their fish in to the dock, you can help create that local farm to the table, that I'm helping my community, I am helping people with jobs, and I am able to eat a local, safe, sustainable product.

And so I think there is a role for states. I don't think, you know—if you don't want somebody there in terms of industry, they likely also don't want to be there because that would be combative. So I think states do have a role in saying what species occur off their coastlines.

Senator SULLIVAN. Great. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Sullivan.

And, Senator Cantwell, anything else?

Senator CANTWELL. I can't wait till Copper River salmon season. [Laughter.]

The CHAIRMAN. OK. I want to referee this one right one here, but . . .

[Laughter.]

Senator CANTWELL. We're in agreement.

The CHAIRMAN. They're in agreement. Yes. All right. Yes, both of you have a great interest in this subject, and it's an important one. And I appreciate our witnesses' testimony today and insights about how we can grow and strengthen and improve the impact of aquaculture on the economy here in the U.S. When we are getting so much of the seafood that we consume in this country from other parts around the world, it makes no sense.

So we appreciate the good work that all of you are doing on that front and look forward to partnering with you in the future and hope that you will share with us your ideas about things that we can be doing along the lines of some of the things you shared today.

And I will ask you, if you will, in response to written questions, and we'll keep the record open for a couple of weeks so that Senators on the Committee, some who weren't here and some who were, can follow up with additional questions that they might want to put on the record. And if you could get those back to us as quickly as possible, that would be greatly appreciated.

But thanks again for your testimony. And with that this hearing is adjourned.

[Whereupon, at 11:39 a.m., the hearing was adjourned.]

A P P E N D I X

STRONGER AMERICA THROUGH SEAFOOD
Wilmington, DE, Feb. 13, 2018

Hon. JOHN THUNE, Chairman,
Senate Committee on Commerce,
Science, and Transportation,
Washington, DC.

Hon. BILL NELSON, Ranking Member,
Senate Committee on Commerce,
Science, and Transportation,
Washington, DC.

Dear Chairman Thune and Ranking Member Nelson,

On behalf of the Stronger America Through Seafood (SATS) Campaign, we would like to thank you for calling a full Committee hearing on the critical issue of domestic aquaculture on Jan. 30, 2018. We ask that this letter of support for the Committee's leadership on domestic aquaculture expansion be included in the written record of the hearing.

With support from seafood leaders from across the country, SATS is uniting American businesses, consumers, health advocates, and NGOs behind a single, positive message regarding the ecological, societal and economic benefits of U.S. seafood production. It was invigorating to hear a diverse panel of witnesses and a bi-partisan panel of Senators all agree on the importance of increasing U.S. production of *healthful, sustainable,* and *affordable* seafood. With this letter, we ask for your continued leadership and partnership in this effort.

Wild fish harvests are and always will be an important part of seafood supply. There is, however, a significant economic and social opportunity for aquaculture to supplement wild harvests in both domestic and international markets. Aquaculture is one of the fastest growing sustainable forms of food production and has the unique potential to improve food security and nutrition, enhance coastal resiliency, create quality jobs, help restore species and habitats, and ensure that seafood (both wild caught and farmed) continues to be an important part of the global food supply.

Unfortunately, domestic aquaculture development is currently constrained by disjointed Federal leadership and numerous regulatory hurdles, including overlapping jurisdiction of federal, state, regional, county and municipal governments, and the absence of a predictable, affordable and efficient permitting process, particularly in marine environments.

To overcome these regulatory hurdles and lay groundwork for strengthening the U.S. aquaculture industry, Congress must demonstrate unequivocal willingness to streamline the existing bureaucracy and support domestic aquaculture development. We strongly recommend legislation to establish the National Oceanic and Atmospheric Administration (NOAA) as the lead agency in charge of overseeing coordination among all Federal partners on U.S. aquaculture interests and on U.S. aquaculture regulation in Federal waters. The legislation should task NOAA with implementing coordinated, consistent and efficient regulatory processes for the marine aquaculture sector, like that outlined in Goal #1 of NOAA Fisheries' Marine Aquaculture Strategy for FY 2016–2020 [1] and make funds available for these activities.

Legislation should also empower NOAA with the authority to remain a strong advocate for all marine aquaculture, facilitate streamlined permitting in Federal waters and increase coordination among agencies with jurisdiction in state waters. Further, as with any new industrial venture, the U.S. marine aquaculture industry will be hugely capitol-intensive, particularly during the first few decades. As such, legislation should provide regulatory certainty and sufficient permit or lease length to maximize success while effectively de-risking the project for potential investors. Attached, please find a document titled *"Investment Considerations Regarding U.S. Offshore Marine Aquaculture"* prepared by Max Holtzman, a partner at Pontos Aqua

[1] *http://www.nmfs.noaa.gov/aquaculture/docs/aquaculture_docs/aquaculture_strategic_plan_final.pdf*

Advisory and a Board Member of the Stronger America Through Seafood campaign, for more background on this topic.

The Stronger America through Seafood Campaign's Board of Directors will be in Washington, D.C. March 14—15, 2018 and we would like to meet with Members of the Committee at that time to discuss these items in greater depth. Please contact us at your convenience to arrange for this meeting. By working together, we will see the responsible development of commercial-scale, affordable aquaculture become a reality for the betterment of our businesses and of our citizens.

Sincerely,

KATHRYN UNGER,
President.

TONY DAL PONTE,
Vice President.

MAX HOLTZMAN,
Secretary.

BILL DEWEY,
Treasurer.

INVESTMENT CONSIDERATIONS REGARDING U.S. OFFSHORE MARINE AQUACULTURE

There have been many conversations related to the length of time of a permit or lease for an offshore marine aquaculture operation contemplated in the proposed Senate Bill related to the U.S. Aquaculture industry. This brief summary attempts present a view from members of the investment community related to permit or lease length and risk assessment in the evaluation of potential investment in an offshore aquaculture operation.

While there are multiple risk factors that must be fully evaluated and properly de-risked in this type of investment analysis, this current discussion is related to one sliver of this de-risking process: The length of time of a permit or lease for a certain operation.

There is no "magic number" related to the length of time either a lease or permit should be, however the longer this time period the more benefits will accrue to the entrepreneurs and companies that wish to start-up this type of operation. A lease or permit with a length of time greater than 20 years would provide benefits to the borrower/investee that maximize the best chance for success while more effectively de-risking the project for potential investors. A brief overview of the reasons for this assumption are included herein.

First, it is helpful to understand the capital intensity of offshore aquaculture operations. Of all of the factors that contribute to this capital intensity, the main drivers in offshore operations are the high cost of cages and infrastructure to support these operations along with very high working capital requirements. These operations typically involve long cycle species which require high amounts of feed, labor and depreciation before they reach the market. Below is further detail of the costs associated with these operations, both offshore, and the necessary onshore support:

Offshore requirements:

- Offshore equipment including cages, barges and service vessels for feeding, harvest, monitoring and general servicing;
- Remote monitoring equipment, remote underwater camera systems, pathogen detection and monitoring;
- Harvesting equipment, including fish pumps, insulated bins and other necessary equipment;
- Labor costs
  - Labor related to construction of site which varies across production methods;
  - FTE's for operations and maintenance;
- Insurance, relevant bonding other capital requirements;

Onshore requirements:

- Research, development and testing of species suitable for relevant siting;
- Maintenance of fleet of vessels to move personnel, equipment and feed from shore to site;
- Dockage of vessels;
- Storage of feed (climate controlled), equipment;

- Harvesting and processing equipment including industrial ice machinery, adequate equipment to move ice and fish to various locations;
- If integrated operation with hatchery, full hatchery and recirculating aquaculture system to operate hatchery;
- Hatchery personnel and equipment;
- Land, buildings, personnel and equipment necessary for hatchery operation;
- If integrated operation with feed mill: full feed mill and capex necessary to construct feedmill including land, buildings, personnel and equipment;

Specific factors related to the need for long lease or permit length:

1. *The highly capital-intensive nature of these operations:* Offshore aquaculture operations are multi-million-dollar agricultural operations with very high initial startup and working capital requirements. There is an often misunderstanding that these operations are simply cages in the water full of fish, when in reality, sustainable modern offshore marine aquaculture relies on cutting edge technology, equipment and highly trained personnel to construct, operate and maintain these facilities. Equipment and facilities are located offshore, and in addition there is a vast land-based network of support infrastructure and personnel to run these operations. While these operations create hundreds of jobs throughout the supply chain necessary to support these operations, the highly capital-intensive nature of start-up and working capital is a major factor related to the necessity of a longer lease or permit period.
2. *Long length of grow-out from hatch to harvest:* Many species suitable for offshore aquaculture operations can take anywhere from 1–3 years to reach harvest from the time of eggs hatching. This longer than typical harvest times compared to terrestrial agricultural protein producers brings additional risk. However, just as with our land based producers, the dynamics are the same: The longer you are controlling a live animal, the more issues you will need to contend with including adverse weather, rising costs of inputs such as feed, risk of disease and other unpredictable but known adversaries. Accordingly, investors will rely on longer capital cycles to flatten out this risk curve across multiple harvests to reduce risk over increased time and volume of product.
3. *Risk of Price Volatility:* Many of the species suitable for offshore aquaculture operations have pricing that are based on and behave like agricultural commodities. The cyclical nature of the pricing of these products then demands that the investment periods must be longer than the cycles themselves. If not, the producer will face much greater risk as you attempt to time your entry and exit within these markets. Long lease or permit lengths allow a producer to both withstand and manage the cyclical nature of commodities and transform unbeatable risk in the short term into manageable volatility in the long run.
4. *Ability to exit the investment and bring new investors:* For a multitude of reasons, owners, operators and investors exit or sell operations during the course of a business. The value of a business will in part be valued by the length of time that remains on a lease or permit. If the initial length of time of the permit or lease is too short, then any subsequent investor will only be able to assign value to the operation based on the remaining time that operation retains its certainty to operate, and thus its ability to generate cash flow.
5. *Risk and Return Expectations:* Different investors have different appetites for risk and return requirements within certain asset classes. Well known in any investment is the higher the risk, the higher the expected returns of the investor. If operating within a short time frame, and therefore higher risk, investors may rightly seek returns that are not aligned with the intrinsic potential of the business. However, if you are able to extend the investment period and decrease the risk, you have the potential to capture investment with more reasonable returns and more aligned with the de-risked intrinsic potential of offshore operations.

PREPARED STATEMENT OF THE NATIONAL AQUACULTURE ASSOCIATION

ACHIEVING SUSTAINABLE SEA FARMING

"We must plant the sea and herd its animals using the sea as farmers instead of hunters. That is what civilization is all about—farming replacing hunting."
~Jacques-Yves Cousteau

The National Aquaculture Association[1] is a U.S. producer-based, non-profit association incorporated in 1991 that supports the establishment of governmental programs that further the common interest of our membership, both as individual producers and as members of the aquaculture community. For over 27 years NAA has been the united voice of the domestic aquaculture sector committed to the continued growth of our industry, working with state and Federal governments to create a business climate conducive to our success, and fostering cost-effective environmental stewardship and sustainability.

The NAA offers the following recommendations with respect to drafting U.S. marine aquaculture legislation to support the creation of a commercially viable framework for U.S. aquaculturists to grow, handle, transport and sell marine finfish, shellfish (clams, oysters, mussels or scallops) and seaweed from farms located in the Exclusive Economic Zone of the United States.

Advancing Public Health, Food Security and Sustainable Economic Growth

Offshore marine aquaculture in the Exclusive Economic Zone holds tremendous potential for advancing the public health, food security and economic interests of Americans, but those interests can only be served if government provides the legal authorities for the private sector to fulfill that mission without unwarranted regulatory obstacles. Large-scale marine aquaculture production in the United States would create the ability to:

- Close a significant gap in U.S. food security (availability) through the farming of seafood products in U.S. waters rather than relying as the United States currently does on foreign seafood sources for 90 percent of the seafood consumed by our citizens.
- Create ancillary equipment and service businesses and new jobs within coastal and inland communities.
- Accelerate technological development to reduce production costs and minimize adverse environmental effects.
- Maintain working waterfronts and build upon the existing and unique knowledge, skills and abilities possessed by commercial fishers.

While these projections are well-documented,[2] the United States has yet to make any significant advances in U.S. marine aquaculture production in the 38 years since passage of the National Aquaculture Act of 1980. Aquaculture production is approximately 45,500 tons valued at $327 million and supplies about 3 percent of U.S. seafood consumption. Federally managed waters beyond coastal state boundaries, termed the Exclusive Economic Zone, encompass 4.4 million square miles (11.3 million square kilometers). A U.S. study estimated that 195 square miles (500 sq. km) of ocean, managed under existing regulations, could produce 1.3 billion pounds (600,000 metric tons) or more of high quality seafood.[3] Theoretically, the farming of 970 sq. miles (2,500 sq. km), an area representing .0002 percent of the Exclusive Economic Zone, less than half the size of Delaware, would double U.S. edible seafood production or an area the size of the Pentagon could produce 220 million pounds (100,000 MT). A doubling of U.S. aquaculture production to about 1 million tons could create an estimated additional 50,000 farm and non-farm jobs.[4]

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[1] National Aquaculture Association, PO Box 12759, Tallahassee, FL 32317; Telephone: 850–216–2400; E-mail: *naa@thenaa.net;* Website: *http://thenaa.net/*.

[2] Rubino, Michael (ed). 2008. Offshore Aquaculture in the United States: Economic Considerations, Implications & Opportunities. U.S. Department of Commerce; Silver Spring, MD; USA. NOAA Technical Memorandum NMFS F/SPO–103

[3] Nash, C.E. 2004. Achieving Policy Objectives to Increase the Value of the Seafood Industry in the United States: The Technical Feasibility and Associated Constraints. Food Policy 29:621–641.

[4] Knapp, G. and M.C. Rubino. 2016. The political economics of marine aquaculture in the United States. Reviews in Fisheries Science and Aquaculture 24(3): 213–229.

Fish Farming is Inherently Efficient

Farmed and wild-caught fish, shellfish and sea vegetables have been recognized as critical components to achieving global food security and nutrition. Farmed and wild fish production have been the main contributor to the 61 percent increase in world protein consumption, fish are very efficient converters of feed into protein, and aquatic animal production systems have a lower carbon footprint, lower nitrogen and phosphorus losses and in the case of shellfish and sea vegetable production remove carbon, nitrogen and phosphorus from the environment. The inherent energy and feed advantages of fish are derived from the "cold-blooded" nature, meaning they expend little to no energy to maintain a constant body temperature, and the physical support water provides to directs growth to protein and not a bony muscular-skeletal structure that is always fighting gravity.[5]

Current Regulations are Proven and Effective

Over the last 20 years, rather than acknowledging the many advances in marine aquaculture production practices and successful management strategies for adverse environmental impacts, many in the environmental community continue to attribute a variety of potential adverse environmental effects to aquaculture based on outdated production methods and standards.[6] We note that the U.S. Environmental Protection Agency (EPA) has held authority to regulate discharges from fish farms (nutrients, chemicals and solid waste) under several iterations of the Clean Water Act since the 1970s. More recently, environmental groups sought EPA reevaluation of the Clean standards applied to aquaculture. During a four-year period, 2000–04, the agency completed a detailed technical review of its then current standards, and modern aquaculture methods, including those used for marine aquaculture. Formal rulemaking was conducted to ensure that Clean Water Act regulations for aquaculture met all standards of environmental protection mandated by Congress. In that process, the EPA determined, contrary to the position of environmental groups, that the proposed and adopted revised regulations assured environmental protection.

Other current Federal regulatory authorities, unilaterally or in partnership with the states, exist to protect navigation and navigational aids, water and benthic quality, food safety, drug and chemical use, aquatic animal health, endangered species, wild fishery stocks (with respect to potential aquaculture impacts to those populations), essential fish habitat, and the opportunity for coastal states to comment on proposed Federal permits and leases associated with offshore marine aquaculture. Existing law include, but are not limited to, the Animal Health Protection Act, Animal Medicinal Use Drug Clarification Act, Coastal Zone Management Act, Endangered Species Act, Federal Food Drug and Cosmetic Act, Federal Insecticide, Fungicide and Rodenticide Act, Federal Water Pollution Control Act (Clean Water Act), Lacey Act, Magnuson-Stevens Fishery Conservation and Management Act, Marine Mammal Protection Act, Migratory Bird Protection Act, National Environmental Policy Act Outer Continental Shelf Lands Act, and Rivers and Harbors Act. Through rulemaking, judicial rulings and an opportunity to comment on significant Federal permitting by other Federal agencies, the U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, U.S. Army Corps of Engineers, U.S. Coast Guard, U.S. Department of Defense, Federal Aviation Administration, U.S. Fish and Wildlife Service, Bureau of Ocean and Energy Management, and state agencies (agriculture, natural resources, and environmental protection) have an important regulatory role relative to offshore aquaculture and, in particular, the coastal states are provided an opportunity to comment on proposed Federal permits and leases associated with offshore marine aquaculture.[7]

Current regulatory authority exists to appropriately protect marine water quality and benthic environmental systems, manage fish escapes, require responsible drug and chemical use, insure safe navigation, and assure consumers that they will have access to safe foods; although, it has been argued, and we agree, that:

> The stringency of the regulatory environment in the United States has increased in recent years in terms of both the number and complexity of regulations that affect U.S. aquaculture. Especially difficult is the common lack of a

[5] Béné, *et al.,* 2015. Feeding 9 billion by 2050—Putting fish back on the menu. Food Security 7(2): 261–274 (*https://link.springer.com/article/10.1007/s12571–015–0427-z* accessed February 1, 2018).

[6] Goldburg, R. and T. Triplett. 1997. Murky Waters: Environmental Effects of Aquaculture in the United States. Environmental Defense Fund, New York NY

[7] Engle, C.R. and N. M. Stone. 2013. Competitiveness of U.S. aquaculture within the current U.S. regulatory framework. Aquaculture Economics and Management 17(3): 251–280.

lead agency at both Federal and state levels to effectively coordinate and streamline regulatory and permitting processes that result in timely decisions and more certainty for investment in new enterprises and expansion of existing operations. The overall cumulative effect has been continued increases in the regulatory costs and risk faced by aquaculture growers in the United States.[8]

Atlantic Salmon in Puget Sound

The potential environmental effects of the escape of Atlantic salmon in Puget Sound on Pacific salmon as a result of a net pen system that collapsed has created intense public and media speculation. Fortunately, several publications have examined this risk and other risks and reported that those risks are manageable or unlikely to be realized.[9]

We believe that when the potential effects associated with this escape are thoroughly analyzed this prior work will be confirmed. We are also hopeful that enough time will have passed to then allow a dispassionate discussion and reassessment of Atlantic salmon culture to occur. We are confident that this assessment will recognize that potential risks are being adequately managed under existing state and Federal regulations. It is also unfortunate, that currently little to no recognition of public and private investment to improve Atlantic salmon production characteristics (*e.g.,* weight gain, feed efficiencies), human diet and nutrition, fish health, and reduced environmental effects through fish husbandry, domestication and technology gained by the global production of Atlantic salmon production has not been made known to the public.[10]

As summarized by Ganesh and Engle (2016) (internal citations deleted):

> The Atlantic salmon industry overcame several biological, ecological, and disease constraints throughout its history. Advanced automated feed monitoring systems provided greater resource and environmental management efficiency. Commercialization of genetic and vaccination programs improved growth and survival while nutritional developments reduced the use of fishmeal and oil while improving performance. Such continued technological advances resulted in continuous growth in Atlantic salmon production with significant reductions in cost of production. The Atlantic salmon industry is one of the leaders in terms of biological knowledge and production technology, raising a very resource-efficient species that is often termed "the super-chicken of the sea." [11]

Research with Significant ROI

Research supported by governmental agencies and the private sector has led to continuing improvements in reducing the use of essential fish meal and fish oil components in pelleted aquaculture feeds. Research programs within NOAA and USDA that focus on marine aquaculture are critical to U.S. aquaculture and to national efforts to reduce our trade deficit, create jobs and increase national security through the provision of wholesome domestic food sources. These aquaculture research efforts have benefited U.S. aquaculture by resolving complex biological, environmental, chemical, or public relations constraints to increase aquatic animal or plant production or sales. Research funds are not wasted public monies. An independent analysis focused on public investment in aquaculture research found an estimated 37-fold return for each research dollar spent since 2000.[12]

States Are Managing Aquaculture

Over the last 20 years, responsible environmental stewardship has become the proven business model in the state or territorial waters of Maine, Washington, Hawaii and Puerto Rico where commercial scale net pens have been operated to farm Atlantic salmon, Almaco jack or cobia and in the state waters of Alabama, Alaska,

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[8] Ibid at 274.

[9] Nash, C.E. (editor). 2001. The net-pen salmon farming industry in the Pacific Northwest. U.S. Department of Commerce. NOAA Tech. Memo. NMFS–NWFSC–49 (*http://www.westcoast.fisheries.noaa.gov/publications/aquaculture/noaa_memo_net_pen_salmon_farming_sept2001.pdf* accessed January 28, 2018).

Waknitz, F.W., T.J. Tynan, C.E. Nash, R.N. Iwamoto, and L.G. Rutter. 2002. Review of potential impacts of Atlantic salmon culture on Puget Sound chinook salmon and Hood Canal summer-run chum salmon evolutionarily significant units. U.S. Department of Commerce. NOAA Tech. Memo. NMFS–NWFSC–53 *http://www.westcoast.fisheries.noaa.gov/publications/aquaculture/waknitz.2002.nwfsc_tm53.reviewofpotentialimpacts.pdf* accessed January 28, 2018)

[10] Kumar, G. and C. R. Engle. 2016. Technological advances that led to growth of shrimp, salmon, and tilapia farming, Reviews in Fisheries Science and Aquaculture, 24(2): 136–152

[11] Ibid at 145.

[12] Love, D.C., I. Gorski and J.P. Fry. 2017. An analysis of nearly one billion dollars of aquaculture grants made by the U.S. Federal Government from 1990 to 2015. Journal of the World Aquaculture Society 48:689–710.

California, Connecticut, Florida, Hawaii, Louisiana, Maine, New Hampshire, New Jersey, New York, Maryland, Massachusetts, North Carolina, Oregon, Rhode Island, Virginia, South Carolina and Washington where shellfish farms have farmed abalone, clams, oysters, mussels or scallops. These farms have been managed in compliance with state and Federal regulations and the provisions of lease agreements with the states or territory. All such operations are conducted with regulatory transparency supported by environmental monitoring data and periodic reporting for these operations in publicly available documentation required by state and Federal agencies.

Creating Security of Tenure is Critical

The limited scope of today's U.S. marine aquaculture industry simply will not substantially expand without access to the majority of offshore waters that are controlled by the Federal Government. However, access alone is not sufficient, and will not create the fertile environment for investment in U.S. marine aquaculture. What is needed is security for tenure (*e.g.,* a lease) to allow U.S. aquaculture operations to operate in the Exclusive Economic Zone in compliance with existing regulatory programs that will provide a viable financial model (private investment and insurance) that will survive in the free market.

Marine aquaculture facilities in the Exclusion Economic Zone must be provided security of tenure to occupy a location to the exclusion of other conflicting uses by means of a recognized and commercially understood legal agreement such as a lease granted by an appropriate Federal agency on behalf of the U.S. Government. Property rights in marine waters are typically available under state laws in state waters where marine aquaculture is recognized as a being in the public interest. This is typically done by means of a lease. The leasing of a public resource for commercial use appropriately requires payment for use of public space (*i.e.,* rental payments). However, this use of public trust lands (offshore "spaces") must be not be confused with business models for industries that actually consume public trust resources (*e.g.,* oil and gas resources that are owned in trust by the U.S. Government for the people).

A viable offshore aquaculture operation will require the same level of commercial certainty and property rights available to land-based agricultural enterprises or those aquaculture farms located in state waters. Offshore aquaculture operations are complex and expensive facilities that require reasonable business planning and construction periods and phased development to provide economies of scale necessary to internalize the regulatory and operation costs. Offshore aquaculture leases should be renewable and should have initial terms of at least 25 years in order to secure financing on commercially-viable terms. Leases should also be transferable to support potential sale or other transfer of a farm operation.

Regulatory Burden and Costs Stifle Small Business Innovation

The majority of U.S. aquaculture producers are small business entities. The USDA Census of Aquaculture conducted in 2012 showed that 86 percent of all aquaculture businesses had sales less than $500,000. The costs of regulatory compliance for small businesses are having devastating effects on the ability of these businesses not only to exist, but to expand or add capacity. Additionally, these same burdens are prohibiting new businesses from starting up, further exacerbating the issue.

As a specific example, the average total regulatory cost on U.S. batfish/spearfish farms was $148,554 per farm, or $2,989 per acre of production.[13] The regulatory cost burden composed 25 percent of total costs of baitfish/sportfish farms, making it one of the largest cost components in their businesses. Total cost to the U.S. baitfish/sportfish industry was estimated to exceed $12 million. On 38 percent of the farms, the cost of regulations exceeded the value of profits on baitfish/sportfish farms.

The data also revealed that only 1 percent of total regulatory costs were those of the fees for permits and licenses. The real burden of the regulatory environment was found to be the indirect costs associated with increased manpower costs for record-keeping, reporting, and applying for permits, farm changes to remain in compliance, and lost sales (that could not be replaced or re-directed to other markets) that were lost directly due to regulatory actions. Environmental management regulations composed 61 percent of the total regulatory cost burden in spite of representing only 17 percent of the total number of regulations with which farms had to comply. The regulatory burden was substantially greater on smaller farms ($5,533 per acre) than on larger farms ($321 per acre), and very likely has contrib-

[13] van Senten, J. and C.R. Engle. 2017. The cost of regulations on U.S. baitfish and Sportfish producers. Journal of the World Aquaculture Society. 48(3): 503–517.

uted to the 29 percent decline in the number of small baitfish/sportfish farms in the United States as compared to no decline in the number of large farms from 2005 to 2012.

Seafood Safety from Farm to Plate

The U.S. domestic aquaculture industry is committed to supplying consumers with consistent, high quality, safe products that are produced in an environmentally sound manner. Numerous Federal and state agencies are involved with maintaining the wholesome attributes of farm-raised seafood. The U.S. Food and Drug Administration works with state departments of agriculture, the Association of Food and Drug Officials, and the American Association of Feed Control Officials to regulate aquaculture food handling and processing and the manufacture of feeds to ensure that they are safe and do not contain contaminants or illegal substances. The U.S. Department of Agriculture inspects the processing of catfish and tests catfish products, foreign and domestic, for contaminants.

The Interstate Shellfish Sanitation Conference in cooperation with the U.S. Food and Drug Administration and state agencies administers a certification program requiring all shellfish dealers to handle, process, and ship shellfish under sanitary conditions and maintain records that the shellfish were harvested from approved waters. State agencies establish standards for shellfish growing areas and regularly monitor water quality to make sure that growing waters meet those standards.

Fish and shellfish packers, warehouses, and processors must comply with the mandatory requirements of the Hazard Analysis Critical Control Point (HACCP) Program administered by the U.S. Food and Drug Administration. The program identifies potential food safety hazards and develops strategies to help ensure that they do not occur. New rules by the U.S. Food and Drug

Administration authorized by the Food Safety Modernization Act have added additional regulations for the processing, handling and transportation of animal feeds and human food. All of these controls help to make farm-raised seafood products safe and wholesome foods.

The United States as a World Leader in Marine Aquaculture

The United States is not a world leader in sustainable aquaculture production by volume or value but we are in the thoughtful and rigorous development of regulatory and nonregulatory production practices, animal nutrition and health management, and the efficient processing and distribution of high-quality, wholesome foods. A recent global analysis of global marine aquaculture potential concluded with a statement that is very relevant to U.S. marine aquaculture in highlights the unlimited potential of the United States to be a global leader in sustainability, technology and production (citations deleted):

> Given the significant potential for marine aquaculture, it is perhaps surprising that the development of new farms is rare. Restrictive regulatory regimes, high costs, economic uncertainty, lack of investment capital, competition and limitations on knowledge transfer into new regions are often cited as impediments to aquaculture development. In addition, concerns surrounding feed sustainability, ocean health and impacts on wild fisheries have created resistance to marine aquaculture development in some areas. While ongoing and significant progress has been made in addressing sustainability issues with marine aquaculture, continued focus on these issues and dedication to ensuring best practices will be a crucial element shaping the future of marine aquaculture. Both the cultural and economic dimensions of development and the management and regulatory systems are critically important to understanding realistic growth trajectories and the repercussions of this growth. Our results show that potential exists for aquaculture to continue its rapid expansion, but more careful analysis and forward-thinking policies will be necessary to ensure that this growth enhances the well-being of people while maintaining, and perhaps enhancing, vibrant and resilient ocean ecosystems.[14]

The National Aquaculture Association requests the U.S. Senate Committee on Commerce, Science, and Transportation create, introduce and shepherd national legislation to lead the world and benefit the Nation. It would be our honor and privilege to assist in this effort as fish, shellfish and sea vegetable farmers with the experience, knowledge, skills, scars and persistence to make this happen.

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[14] Gentry, *et al.,* 2017. Mapping the global potential for marine aquaculture. Nature Ecology and Evolution 1:1317-1324.

WRITTEN COMMENTS SUBMITTED BY THE SAN DIEGO UNIFIED PORT DISTRICT

In follow up to the testimony that you heard from our stakeholders and colleagues on January 30, 2018, the San Diego Unified Port District (District) would like to provide additional comments regarding developing aquaculture opportunities as public private partnerships.

The District serves the people of California as a special district, balancing multiple uses on 34 miles along San Diego Bay spanning five cities. Collecting no tax dollars, the District manages a diverse portfolio to generate revenues that support vital public services and amenities.

The District champions Maritime, Waterfront Development, Public Safety, Experiences and Environment, all focused on enriching the relationship people and businesses have with our dynamic waterfront. From cargo and cruise terminals to hotels and restaurants, from marinas to museums, from 22 public parks to countless events, the District contributes to the region's prosperity and remarkable way of life on a daily basis.

Background

As you heard from Mr. Don Kent during oral testimony, on October 8, 2014, Rose Canyon Fisheries (RCF) submitted permit applications to the U.S. Army Corps of Engineers (ACOE), and the U.S. Environmental Protection Agency (EPA) for a fish farm to be located in Federal waters, 4.5 miles off the coast of San Diego, CA. This represented the third, but most comprehensive attempt at permitting for an offshore fish farm in California since 2002.

In the ensuing months RCF experienced multiple delays due to a lack of Federal agency coordination, including a debate on which agency (ACOE or EPA) should take the lead agency role in coordinating the National Environmental Policy Act (NEPA), a critical step in moving the applications forward Each agency did initiate their own Notice of Intent's (NOI) to begin processing applications including public scoping processes, and the EPA did agree to become the lead agency in February of 2015. However, by June of 2016, the EPA had cancelled their agreement to become the lead agency and the ACOE informed RCF that it would deny their Section 10 Permit application based on concerns about navigation cited in the Navy's original comments, despite the same comments that suggested the farm location move slightly to the north to minimize potential interference with Naval operations. By the end of 2016, NOAA Fisheries Regulatory Branch offered to step in and be the lead agency on the NEPA review for the RCF permits. While this was a welcome and significant step forward, the regulatory quagmire and interagency inaction resulting from the lack of a clear sense of priority and efficiency amongst agencies continued. In April 2017 (30 months following application submittal), the District intervened and hosted a meeting with the National Oceanic and Atmospheric Administration (NOAA), the U.S. Navy, and the ACOE. The U.S. Navy re-iterated its support for the proposal, and while the ACOE was still reluctant, it did agree to RCF updating its application materials to reflect the new site location and re-submitting an application package.

In August 2017, the District hosted the first-ever, interagency pre-application meeting for an offshore aquaculture permit application in the U.S. NOAA, now officially the designated lead agency, organized the meeting which included representatives from NOAA, ACOE, EPA, U.S. Coast Guard, U.S. Navy, California Coastal Commission, California Department of Fish and Wildlife, Rose Canyon Fisheries, and the District.

Through the District's Blue Economy Incubator Program, the District is exploring a partnership with RCF, which has the potential to be a regional-based model and an early proving ground that will provide an invaluable database of information and advance the aquaculture industry nationwide. The District has been asked to act as a Cooperating Agency, along with NOAA, ACOE, and EPA for the National Environmental Policy Act (NEPA) review for this project. Next steps are currently being discussed, along with a draft MOU that outlines each agencies roles and responsibilities.

The Opportunity for Aquaculture

There is a clear opportunity and critical need to support development of sustainable domestic marine aquaculture industry. The U.S. currently imports over 91 percent of the seafood it consumes, yet only three percent of U.S. domestically produced seafood comes from aquaculture. In economic terms, these imports consistently contribute to a nearly $14 billion domestic seafood trade deficit each year. U.S. based aquaculture advocates, however, believe we can reverse that trend and allow aquaculture to flourish right here at home. The U.S. could and should be self-sufficient

in seafood production with the goal of becoming a net trade exporter of seafood by 2050.

The largest opportunity for U.S. aquaculture development lies offshore, but the required Federal permitting process is poorly defined. This has caused domestic investment in aquaculture to be driven to other countries. Besides being the major contributor to our trade deficit, this also sends U.S. seafood production and distribution industry jobs to other countries, thereby losing a major economic opportunity for the U.S. As you heard during oral testimony, for every one job created on the waterfront, two additional indirect jobs are created elsewhere downstream. The import deficit also means that the U.S. is buying seafood that may not be grown to our rigorous health and environmental standards. There are numerous examples of U.S. investors growing salmon in Chile, red drum, striped bass and yellowtail in Mexico and cobia in Panama, simply because those countries welcome their investments. Any one of these companies would rather be working in U.S. waters, but they cannot get the permits required from the Federal Government that they need to locate and operate U.S. farms.

The Port of San Diego's Role

Aquaculture must be tested and proven to be economically, environmentally and commercially viable. This takes time, money, expertise and regulatory wherewithal. The District has positioned itself uniquely to supports efforts to advance State and Federal policies to increase aquaculture production and deliver a safe, secure and sustainable seafood supply for California and the Nation. Ports can and are increasingly playing a critical role in the development of sustainable aquaculture, given their familiarity and expertise in the permitting and entitlement process for a variety of coastal and ocean uses; the unique role they often play as a landlord, operator and/or regulator, and as champions of the blue economy. As the state-legislated trustee of tidelands (*i.e.,* land and water) around San Diego Bay, developing sustainable domestic aquaculture helps fulfill the District's public trust responsibility to promote fisheries and commerce, as well as aligning with its mission to enhance and protect the environment.

As the state-legislated trustee of tidelands (*i.e.,* land and water) around San Diego Bay, developing sustainable domestic aquaculture helps fulfill the Port's public trust responsibility to promote fisheries and commerce, as well as aligning with its mission to enhance and protect the environment.

San Diego could support the development of an offshore aquaculture industry, which could become a $1 billion per year industry with only a nominal percentage of state or Federal waters leased from the government. A properly constructed and managed industry would provide a safe, secure, and stable supply of healthful seafood to the region, alleviate some pressure on wild fish stocks, and help conserve the remaining working waterfront, all with acceptable impacts on the environment and other ocean uses. Equally as important, an aquaculture facility in our region could prove the viability of the domestic aquaculture industry and act as a catalyst for growth of the industry nationwide.

The Pressing Need for Congressional Action

To address the challenges above, it is essential to have a predictable and systematic approach to permitting and leasing within Federal waters to support and accelerate growth of a domestic aquaculture industry. As our colleagues and stakeholders stated during their testimony, the lack of Federal leadership in the permitting process not only slows the process, but hampers access to private investment, research, and development of the industry as a whole. The District supports legislation that provides NOAA with a leadership role in aquaculture development for our nation, including but not limited to:

- Designating NOAA as the lead agency for aquaculture in Federal waters and creating a streamlined regulatory process,
- Providing support for the National Marine Aquaculture Initiative (NMAI), including a mechanism for long term research and development support, and
- Facilitating regional projects in support of sustainable offshore aquaculture industry Development

We have worked with NOAA over the years in support of environmentally and economically important issues that affect our region and our Nation and very much look forward to engaging with the Department of Commerce to advance sustainable offshore aquaculture in our Nation.

The Time to Act Is Now

The time is ripe for a forward-thinking strategy that embraces our natural resources. After all, our Nation's independence depends on our ability to be self-reliant, and not depend on the resources of other nations. We believe that the solutions to our challenges are home-grown, and in San Diego, we intend to play a role in crafting those solutions. The District stands ready to commit our resources and experience in this area in collaboration with our partners and stakeholders. We have the expertise, infrastructure, relationships and marine based regulatory experience needed to substantially contribute to this successful venture. We are hopeful that the Department of the Interior and the current administration agrees with our assessment on aquaculture and can provide resources and regulatory assistance.

The District stands ready to work with the Department of Commerce and other Federal agencies involved in the permitting process to advance aquaculture in our Nation and demonstrate the sustainable development of a domestic seafood industry that both creates jobs and lowers our dependence on seafood imports.

We thank you for your leadership on these issues and look forward to working with you on behalf of the United States' interests and the benefit of all those we serve. If you have any questions please do not hesitate to contact the President/CEO, Randa Coniglio at 619–686–6201, or Job Nelson, Vice President, External Relations at *jnelson@portofsandiego.org* or 619–686–7274

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ROGER F. WICKER TO MARK LUECKE

Question 1. Is there a link between two reasons for slow domestic growth of aquaculture you identified, namely the "unavailability of investment capital to construct more fish production facilities" and "an inefficient regulatory pathway permitting fish production facilities"?

Answer. There is a *direct* link between an inefficient regulatory pathway permitting fish production facilities and the unavailability of investment capital to construct more fish production facilities, leading to slow domestic aquaculture growth.

Capital sources, such as private equity investors and banks, will only provide capital to projects where there is (1) a clear understanding of risk and (2) a clear plan to manage that risk in order to generate a reasonable return on their invested capital. Given the current inefficiency and uncertainty experienced by organizations attempting to permit fish production facilities, capital sources are unable to obtain a good understanding of the regulatory risk, much less outline a regulatory management plan, and therefore, they do not place their capital at risk.

This inefficiency and uncertainty stems from the lack of a clear regulatory pathway to place and retain fish production facilities in service. Without a defined lead agency at the Federal level for environmental review and approval of these projects, the U.S. will continue to experience a large and growing trade deficit in this critical food category.

Private capital sources will simply not fund projects where there is inefficiency and uncertainty.

Question 2. Should permits or leases for marine aquaculture production facilities be of a long enough duration for investors to have the opportunity to see a return on their investment?

Answer. It is imperative that permits and leases for marine aquaculture production facilities be no less than ten (10) years, and preferably twenty (20) years, with an opportunity to extend that time period if all conditions of the permit and/or lease are being met.

Quite simply, if permits or leases are not of a long enough duration for capital sources to generate a reasonable return on their invested capital, they will simply place capital in other projects in other segments of the market. This will cause the U.S. to continue to experience a large and growing trade deficit in this critical food category.

Incentives for capital sources to participate in the domestic aquaculture market must be established to stimulate its growth, starting with long-term permits and leases.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ROGER F. WICKER TO DR. KELLY LUCAS

Question 1. What type of assurances—particularly related to permitting—do aquaculture businesses and entrepreneurs require to make offshore aquaculture more attractive to investors?

Answer. Businesses need regulatory certainty to reduce the risk of investment. They need to know they can get a permit. There needs to be a streamlined, transparent, permitting process. They need one agency to take ownership of the permitting process. I would suggest NOAA can lead the process and can lead the necessary environmental reviews. Other agencies will still need to supply the permits necessary by law, but it would be efficient to have a designated agency coordinating the process. Industry needs permits that are long enough in terms of duration that they can not only capitalize the expenses, but they can see a return on their investment. They need certainty that they will be able to renew their permits as long as they abide by the regulations, monitoring and reporting requirements.

Question 2. How can marine aquaculture be compatible with and supportive of the commercial fishing industry?

Answer. First, we need make sure the message is clear that aquaculture is not trying to replace commercial fishing. World-wide, wild capture fisheries is stagnant and has been since the 1990s. We are fishing at maximum sustainable yield and in some cases over sustainable yield. In order to meet the increasing demand for seafood, aquaculture will be necessary but it will also be necessary for us to continue to have sustainable wild-capture fisheries. Offshore and nearshore aquaculture shares a lot of the same infrastructure and equipment in terms of working waterfronts, processing plants, seafood markets, boats and boat repair with the commercial industry and working together both industries can benefit.

Question 3. What are the key research areas we ought to invest in to continue U.S. leadership in marine aquaculture?

Answer. We need to invest in larviculture, genetics, aquatic health management, feeds, advanced technology and engineering. The development of hatchery capacity and refinement of culture techniques is vital to offshore development. Commercial operators need a reliable and consistent source of disease free larval fish. Some larval fish species can be reliably supplied, many other species that are high value and fast-growing lack sufficient research development. The use of selective breeding as a tool to increase production is far behind the plant and farm animal industries. Selective breeding of fish using genetics to aid selection can generally be completed in less time than breeding of farm animals. Domestication of new species and offshore culture will require monitoring and adaptive health management plans to reduce and prevent disease and outbreaks. Although we have made advancements in fish feed and have reduced reliance on forage fish, we should continue to identify alternative sustainable feeds for large-scale aquaculture. Improvements in net and cage technology have decreased chances of escapes; however, we can continue to improve containment systems with new materials and with remote detection technology. Unmanned systems and artificial intelligence can aid operators in task such as cleaning cages, feeding fish and detecting potential problems.

Question 4. Does regulating marine aquaculture under the Magnuson-Stevens Act work?

Answer. There is great concern among the industry and others that the Magnuson-Stevens Act (MSA) in not the correct tool to regulate marine aquaculture. Whereas the offshore aquaculture industry shares some things in common with the commercial fishing industry, regulating domesticated fish in a comparable manner as wild fish does not work. MSA is not the correct mechanism for regulatory elements such as permitting and aquaculture facility management and monitoring.

Question 5. Why is genetics research important for marine aquaculture, particularly with respect to fish production, fish health, and interactions with wild fish stocks?

Answer. Genetic level information and genome sequencing is important for wild fish stocks and to aid in aquaculture development. Population level genetic research has contributed to knowledge of how fish are structured into reproductive populations and how these populations are distributed. At TCMAC we use genetics to provide information about local populations of spotted sea trout. We use this information to isolate broodstock, ensure genetic diversity and release hatchery reared fish back into their watershed. The genetic markers can also be used to indicate if a captured fish was reared in the hatchery. Additionally, we use genetics to help assist with selection of species for breeding for commercial aquaculture applications. These genetic tools can aid in selecting against a genetic disorder or condition or

selecting for a value-added trait such as fast growth. These tools can also be used to select for entire genomes. The use of selective breeding as a tool to increase aquaculture production is far behind the plant and farm animal industries and selective breeding of fish can generally be completed in less time than breeding of farm animals.

Question 6. Should permits or leases for marine aquaculture production facilities be of a long enough duration for investors to have the opportunity to see a return on their investment?

Answer. The duration of the lease and/or permits should be long enough for industry to capture the cost of capital and make a profit on their investment.

Question 7. Are there environmental benefits to locating marine aquaculture farms further offshore, such as in the exclusive economic zone?

Answer. Open-ocean aquaculture can reduce some environmental concerns that we see in nearshore environments by siting farms away from sensitive habitats in deep waters with adequate currents the potential pollution would be reduced.

Question 8. Would a permit to operate a marine aquaculture facility be sufficiently secure to provide investors with the certainty to invest in a marine aquaculture operation?

Answer. There is concern with the industry that a permit only gives an individual or company the authority to operate and does not provide the property rights necessary to provide business security. If a company was conducting aquaculture in Mississippi state waters, the company would need a lease of the water bottoms and would also need a permit to conduct the aquaculture activity. Several states have similar models of requiring both a lease and a permit.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO DR. KELLY LUCAS

Question 1. General Marine Aquaculture: What are your top recommendations for building a marine aquaculture industry while preserving our environment and traditional fisheries?

Answer. Businesses need regulatory certainty to reduce the risk of investment. Congress should enact legislation to provide a regulatory framework for offshore aquaculture. The regulatory framework should be structured to provide an avenue for permit approval. One agency should be the lead for the permit process. I would suggest NOAA can lead the process and can lead the necessary environmental reviews. Other agencies will still need to supply the permits necessary by law, but it would be efficient to have a designated agency coordinating the process.

Supporting aquaculture development by similar mechanisms used to support agriculture can help industry grow. The agriculture industry grew tremendously from public support of research occurring at universities, state and Federal laboratories and research stations spread across the Nation to bring techniques directly to farmers. Aquaculture can benefit from a similar approach of competitive research funding and extension funding to advance research and development. Advancement of aquaculture, especially selective breeding, health management and culture techniques can take multiple years for significant gains and long-term funding programs will be critical to success.

Aquaculture can help expand our supply of local, safe, sustainable seafood. Fish are more efficient converters of feed to meat and the ability to produce a steady fish supply can meet the increasing demand for protein. We have robust environmental laws in the United States that help ensure we operate in environmentally safe manner. We also have regulations regarding fish health and treatment of fish for consumption. Open-ocean aquaculture can reduce some environmental concerns that we see in nearshore environments by siting farms away from sensitive habitats in deep waters with adequate currents the potential pollution would be reduced. We also should continue to grow land-based and near-shore aquaculture. Land-based aquaculture in recirculating closed loop systems is advantageous for numerous reasons. Some benefits of the controlled environment in recirculating systems is the increased biosecurity and ability to increase production through year-round growth. Water reuse through filtration and sterilization also increases the sustainability of closed-loop recirculating systems. The ability to locate the facilities in areas of market supply helps create local jobs and supplies safe, fresh, local, seafood for consumers. Near-shore aquaculture in the United States has been increasing. Shellfish aquaculture has increased significantly along all United States shorelines and seaweed aquaculture have been increasing in several regions of the United States. This

un-fed aquaculture in near-shore locations has environmental benefits of improving water quality and providing habitat.

We need to think of aquaculture as diversification and not a replacement for commercial fishing. We need make sure the message is clear that aquaculture is not trying to replace commercial fishing. World-wide, wild capture fisheries is stagnant and has been since the 1990s. We are fishing at maximum sustainable yield and in some cases over sustainable yield. In order to meet the increasing demand for seafood, aquaculture will be necessary, but it will also be necessary for us to continue to have sustainable wild-capture fisheries. Offshore and nearshore aquaculture shares a lot of the same infrastructure and equipment in terms of working waterfronts, processing plants, seafood markets, boats and boat repair with the commercial industry and working together both industries can benefit. For recreational anglers off-shore and near-shore aquaculture creates habitat that attracts fish. Allowing anglers to fish near these structures can provide increased fishing opportunities. In addition to that bait fish can be cultured that benefit both the recreational and commercial industries. Both the commercial and recreational communities have benefited from stock enhancement and aquaculture-based restoration efforts.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. CATHERINE CORTEZ MASTO TO DR. KELLY LUCAS

Question 1. Las Vegas receives 42 million annual visitors and has a local population of around two million. We depend on a responsible and clean level of drinking water sources. Unfortunately we're experiencing record-low water levels at Lake Mead. How can we ensure a balance of creating more aquaculture opportunities in the southwest, while also maintaining the dependable water sources we desperately need to survive and thrive?

Answer. One suggestion I can offer is diversification of aquaculture to include recirculating aquaculture systems. Recirculating aquaculture systems operate by filtering water and cleaning the water to remove waste and reuse the water. Often the removed waste products can be used for alternate activities such as growing plants. Ponds can also be outfitted in ways to recirculate and filter water for reuse.

Question 2. Electricity is obviously required for pumps used in aquaculture and aquaponics. Are there any studies on the use of renewable sources of energy to help maintain the power to these operations?

Answer. The cost of electricity can be significant for aquaculture operations and businesses look for ways to reduce cost. One example of using renewable energy is the use of sunlight to grow algae. The algae can be the end product or can be used as feed for other aquaculture activities such as feed in a hatchery. Another example is the use of the tide to tumble oysters in a bag to create the desired oyster shell growth. Also, solar energy can be used for automated fish feeders and monitoring systems. There is ongoing research for using renewable energy in aquaculture and as renewable energy technology increases so will numerous uses for this technology in aquaculture.

Question 3. Are there opportunities to utilize geothermal technologies specifically that you have seen in your work?

Answer. Geothermal energy is used in aquaculture to heat water for ponds, raceways and tanks. Geothermal energy can also be used to heat greenhouses and aquaculture facilities.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. ROGER F. WICKER TO BARTON SEAVER

Question. From your experience in Maine, how can marine aquaculture be compatible with and supportive of the commercial fishing industry?

Answer. In Maine, as is true in many fishing communities, we have seen the proud tradition of wild fisheries atrophy in the wake of mismanagement, foreign competition, and changing habitats. And yet these communities somehow remain resilient, finding ways to continue to pursue the iconic profession of fishing on the open water.

Wild fisheries have a long and strong tradition of apprenticeship, where the older generation passes its skills and knowledge on to the upcoming generations through side-by-side collaboration. But a serious issue facing wild fisheries is the graying of the fleets. As rural communities and less profitable fisheries are less able to attract young labor the average age of fishermen is increasing. The aquaculture industry

represents an exciting combination of technology, innovation, environmental stewardship and sustainable food production that can attract younger residents.

But this does not have to devolve into a competition between the two industries, between generations. Rather, it is a perfect opportunity for the experienced fishermen and women to serve as mentors to the budding aquaculturists, sharing their knowledge of the local ecosystems, best economic and sustainability practices, and navigation of the supply chain. By participating in the growth of a young aquaculture industry, experienced fishermen and women are celebrated for their heritage and can serve as catalysts to a new economy, fostering the emerging workforce that will settle into coastal communities and maintain their vibrancy.

In Maine, there are over 4,000 individual, owner-operated lobstermen and women who already possess the transportation equipment, have established a sophisticated cold storage supply chain, and built the markets to successfully distribute and sell seafood. Much of the risk and cost involved in an aquaculture start-up is the creation of these systems beyond the farm itself. The existing support systems, as well as the people already working the water could allow rural coastal economies to diversify into farming to augment their wild capture.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO BARTON SEAVER

Question 1. General Marine Aquaculture: What are your top recommendations for building a marine aquaculture industry while preserving our environment and traditional fisheries?

Answer. It is my belief, and I can point to many examples of collaboration in my home state of Maine, that wild fisheries and marine aquaculture not are inherently at odds. The existence of one, does not diminish the other in anyway. But to answer your question more directly, I do have recommendations that could help both thrive at the same time.

- I recommend the United States heavily invest in the development of modern aquaculture much in the same way it invested in the development of the agriculture industry post World War II. Making more seafood available to more Americans will raise the consumer confidence in, and the market value of, both wild caught and farmed seafood. A made-in-the-USA label is a powerful mark of civic and economic virtue. Investing in aquaculture as a national priority will send a very clear message calling needed attention to the opportunities for this Nation to better utilize our marine resources.
- I recommend that we as a nation ensure that best fish farming practices are followed to protect the environment, wild fisheries and our citizenry. But I also recommend that specific regulations in any given region be implemented with a firm understanding of that region's maritime culture and heritage.
- I recommend the government invest in community and economic development programs based on an apprenticeship model through which wild fishery and aquaculture participants can find mentorship opportunities in each other and create cross-industry collaborations.

Question 2. Mr. Seaver, as a restaurant owner and chef you have seen first-hand the expectation consumers have about the quality, origin, and nutritional value of the food they eat. How would consumers benefit from more marine aquaculture?

Answer. It is important to recognize that seafood is categorically one of the healthiest foods humans can eat. As a matter of public health, we must work to increase seafood consumption just to meet our own government's recommendations for twice weekly consumption of fish for every American. A limiting factor in seafood consumption to date is a neutral, or often negative, perception of farmed seafood. It is not a stretch to say that developing the United State aquaculture industry as a trusted source for seafood would lead to increased consumer confidence and consumption.

Question 3. What kind of regulations or standards for marine aquaculture do you see as necessary to preserve the health and safety of consumers and the environment?

Answer. There are excellent standards for industry best practices that are constantly evolving due to emerging science and technological innovation. While I am not an expert and defer to others on specific regulations, I can state with confidence that we know how to farm seafood in environmentally friendly ways that produces healthy food.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. EDWARD MARKEY TO BARTON SEAVER

Question 1. Senator Wicker and I worked together to help create the Seafood Import Monitoring Program, which was just fully implemented at the beginning of this year. This program will help reduce Illegal, Unreported, and Unregulated (IUU) fishing for specific species because it requires importers to include data on where and when the fish was landed and who landed it. However, this data is not consumer-facing. In your restaurants, you highly valued traceability and trained your staff to tell the story of how each customer's fish arrived on their plate. How can we expand these stories beyond high-end restaurants and make them more accessible to consumers on a daily basis—from fast food to supermarkets?

Answer. I believe traceability from dock to dish must take many forms, each one suited to the particular type of operation in which it is practiced.

In white table cloth restaurants, we have the luxury of extended customer engagement and the flexibility of daily changing menus that reduce the risk of offering new products. We have the time to tell every detail of the fish's origin, but if it doesn't sell well, we can take it off the menu the next day without too much monetary loss.

But in the case of a large food service operation—where the customer interaction is shorter and purchasing a variety of seafood products comes at a cost. Often there is a lower level of culinary skill and thus less ability to adapt to the nuances of variable sourcing. In such operations it is common to find menus that consistently list a single species that must be sourced from wherever it is currently available. In such cases it is more appropriate to communicate an operator's commitment to a considered set of civic and environmental values regarding the fish being served. It is rare in such scenarios that it is feasible to list the specific fishing boat that captured it. The solution is to commit to sourcing from certain regions where the fish is sustainably managed and to communicate region or provenance as the best means to connect the ingredient back to the producer community.

The point is to elevate American seafood in general as a trusted seal of quality and sustainability. Just as the Magnuson-Stevens Act serves to validate American-caught seafood as sustainable, so would a robust national aquaculture policy based on best practices and the best science provide the same level of confidence in farmed seafood.

Question 2. The Cape Cod Commercial Fishermen's Alliance in Massachusetts has been working with the seafood distribution company Sea to Table to build domestic markets for locally caught spiny dogfish. Spiny dogfish is not well known to American consumers, but is delicious in fish and chips, or in tacos. How can we expand these sorts of programs so that Americans can enjoy local, plentiful fish that they might not currently recognize by name or appearance?

Answer. Dogfish has long been the bane of fishermen in New England. It was an unwelcome catch when the profitable cod was the target. And despite its abundance and affordable price it has never enjoyed any significant popularity at market. To counter this our government undertook multiple efforts to advertise its qualities, even promoting its use as a "fighting food" for those on the home front. It was even marketed under a variety of more romantic names such as Harbor Halibut, Mustel, and Cape Shark.

Personally I never have understood the problem with the name dogfish. We eat plenty of catfish in this country with no complaint. But these efforts never amounted to any lasting economic impact for fishermen. Although history would suggest that there is something less desirable about dogfish, it is simply due to a lingering cultural bias that has unfairly regarded this truly delicious fish as a stain upon creation. But as has been proven by the Sea to Table efforts, when stripped of any stigma, consumers find it to be among the tastiest of all the white-fleshed fish varieties common to New England.

And that leads to my recommendation that we educate chefs and consumers about seafood by focusing on the culinary qualities of the fish rather than the species name. Dogfish cooks the same as cod as haddock as cusk as hake . . . While a consumer might not know what hake tastes like they certainly know what flaky white-fleshed fish tastes like. The best place to implement such education programs is in college and university food service operations. Students are often willing to experiment and try new ingredients. And it offers a logistically simple but high volume and high impact means to sell product and to influence future consumers. But foodservice operators are hesitant to take risks on serving something the students will reject and end up wasting. Education initiatives subsidized by state extension or Sea Grant programs can help reduce the financial pressure and risk in introducing new fish. And once the students approve, the market is there, and companies

like Sea to Table and community organizations like the CCCFA are then able to supply those markets and connect students with producers.

Seafood cookery is unnecessarily complicated by our irrational preferences for a single species or another. I know too many people who swear by rockfish but swear off striped bass (they are actually the exact same fish). When we start with the familiar, say a fish taco, all of a sudden the dogfish inside isn't so exotic. I by no means condone fish fraud. We must always label seafood as the species it is. But why try to sell dogfish when you can much more easily sell a fish taco made with dogfish. Sell the dish and not the fish. It's a simple method that allows consumers to engage with fisheries in a rational way. Instead of demanding of the oceans and of fishermen only cod, we must ask of them what they are able to provide. In doing so we shift the entire economy of fisheries from one based on irrational demand to one based on sustainable supply. Sustainable meaning that it is often better for the environment and it allows fishermen to earn the deserved value of whatever delicious fish they happen to haul up.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. CATHERINE CORTEZ MASTO TO BARTON SEAVER

Question 1. It is not a stretch to say that developing the U.S. aquaculture industry as a trusted source for seafood could lead to increased consumer confidence and consumption, correct?

Answer. Yes, I believe that to be true. A robust American aquaculture industry, regulated for safety and environmental sustainability, would result in increased consumer confidence in and consumption of American seafood.

Question 2. How we do ensure that low-income individuals and families can still have access to this dietary benefit?

Answer. As the aquaculture industry matures, there will be technological advances made and efficiencies realized that will reduce the cost of American seafood to the consumer. It is also important to note that aquaculture isn't limited to farming fish in the oceans. There are technologically advanced self-circulating systems used to farm many species of fish that can be set up in an old warehouse in Detroit or in an empty strip mall in rural American. Not only will these aquaculture operations provide increased access to fish in these areas, they could also result in employment opportunities. There are great examples of these systems such as an urban farm in Milwaukee where visionary community member Will Allen has proven both nutrition and community benefits result from these efforts.

Question 3. Furthermore, how can we make it economical enough to allow for its viability in food assistance programs and its inclusion in the school lunches that often is the main source of nutrition and comprehensive meals for millions of American youth?

Answer. Given the prodigious potential for aquaculture production, strong governmental support for growth in this industry, much like was done for agriculture commodities, could lead to a scale of production that will enable the farming of healthy, nutritious seafood that will fit within the tight budgetary parameters of food assistance and school lunch programs. There are great programs already being implemented for getting more wild-caught seafood at affordable prices into the schools, institutions, and food assistance programs in both Massachusetts and Maine. These programs, like the Mass Farm to School initiative that embraces seafood as a basic tenet of its program (*https://www.massfarmtoschool.org/announcement/sea-to-school-takeaways/*) could serve as models for farmed fish distribution and consumption in those venue across the country.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ROGER F. WICKER TO DONALD B. KENT

Question 1. What type of assurances—particularly related to permitting—do aquaculture businesses and entrepreneurs require to make offshore aquaculture more attractive to investors?

Answer. As in any enterprise, investors are looking for some assurance of an investment return, and to realize that return, permits are needed to not only allow the business to operate, but to also shape the scope of the operation and to define operational protocols. Here in the U.S., we have many of the required operational protocols understood because of existing laws and regulations for operating in U.S. waters and for growing food, but what we lack is any assurance of acquiring the permits because the permitting process is not clearly delineated and many years

and millions in investment can be wasted trying to acquire permits. In juxtaposition to this is Mexico, where a very clear permitting path is laid out, and permits can be acquired within a six month time frame at a cost of about $50,000. Because of this reliability, American investors seek Mexican partners and operate their farms in Mexico and then sell the seafood back into the U.S., even though the resulting product may not meet our rigorous environmental and public health regulations. I do not mean to suggest that imported seafood is unsafe, only that it is more difficult to ensure that it meets our standards if we are not growing it ourselves. What is needed is a consistent, well-defined permitting pathway that builds upon existing U.S. laws and regulatory processes and that can be applied across the Nation so to allow investors. This pathway should:

- Reiterate the authorities assigned by existing law to agencies (*e.g.,* issuance of Section 10 permit by U.S. Army Corps of Engineers, issuance of NPDES permit by EPA).
- Require the issuance of an Aquaculture Permit by NOAA Fisheries for any farm located in Federal waters outside state coastal jurisdiction.
- Reaffirm State's authorities and responsibilities under the CZMA.
- Establish that NOAA Fisheries should be the lead agency for NEPA review based on its aquaculture, marine resource, and NEPA expertise
- Define the criteria by which the extent of the NEPA review (*i.e.,* Environmental Assessment or an Environmental Impact Statement) will be decided.

Question 2. How would ports and working waterfronts benefit from a growing marine aquaculture industry?

Answer. Our nation's marine fisheries are well managed and many that had been over-exploited are now harvested sustainably thereby providing longer-term security in the supply of those harvested species. But, we all know relying only on domestic fisheries isn't enough, especially if we have had to curtail harvests to ensure long-term sustainability. Aquaculture holds the promise of keeping working waterfronts working.

Much of the infrastructure needed to support commercial fishing (dock space for loading/unloading, ice machines, fish processing, fuel, covered storage space, etc.) is also needed for farming operations. The primary difference is that commercial fishers harvest wild fish and farmers harvest farmed fish and both need space on-shore to support their open ocean operations. By supporting both commercial fishing and farming, our Nation's ports will get a double return on their investment in this infrastructure and realize a far greater economic return as a result of job creation and support.

Question 3. Can you describe in detail the employment opportunities offered by an offshore marine finfish aquaculture operation?

Answer. Marine farms provide a wide range of opportunities for job creation. Direct jobs on the farm represent an opening for commercial fishers who have existing skill sets (piloting vessels in rough seas, harvesting fish, managing nets, etc.) that are needed for working in the open ocean environment. Besides the direct jobs on the farm raising fish, there are jobs associated with processing and distributing the farmed product, maintaining vessels, delivering feed and other business support activities. For the farm we propose off the coast of southern California, the San Diego Economic Development Corporation predicts that on top of the 72 jobs created by farm operations, an additional 300 jobs would be created and supported by the farming operations. This seems consistent with studies conducted in Canada where they found that for every thousand tons of salmon production, there are 43 jobs created and supported over the long term. Using that rough estimator, a regional increase of 100 thousand tons of fish production in the open ocean would support over 4,000 new jobs in and around the farms' region of operations.

Question 4. Would a permit to operate a marine aquaculture facility be sufficiently secure to provide investors with the certainty to invest in a marine aquaculture operation?

Answer. Many industries rely on permits as their primary method of government regulation that guides their operations. For example:

- Business permits issued by a municipality to operate in a given community.
- Specialty permits for truck drivers to operate long haul vehicles across the Nation.
- Licenses for certifying the qualifications of doctors, lawyers, CPAs and other professionals.

Permits are the interactive system by which our government regulates industry on a day-to-day basis. What is expected in permits from Federal agencies (U.S. Army Corps of Engineers, U.S. Coast Guard, EPA) for offshore farms are conditions to the permits developed to evaluate, avoid or mitigate and monitor for possible environmental effects and impacts to other users. These would be developed as part of the NEPA review and regulatory permitting process. As long as the conditions are not unnecessarily restrictive, then the resulting permits are adequate to allow appropriate farming operations.

Question 5. Should permits or leases for marine aquaculture production facilities be of a long enough duration for investors to have the opportunity to see a return on their investment?

Answer. Permits or leases HAVE to be of long enough duration to allow profitability. An offshore farming operation is capital intensive and the profit margins, like most farming operations, are not that high, so adequate time has to be allowed to permit a return on the investment. A typical scenario would require two years to acquire permits, a year of mobilization, and at least one year, probably two, for product to enter the market. A 2,000 ton farm would likely require and investment of at least$15 million, with annual sales not commencing until at least year five with profitability realized sometime after that. A ten-year permit would mean that a farm would only have three or four years to realize an investment return.

Permits or leases should act like drivers' licenses:

> Here is the rule book to go with your license. Don't break the rules, and we'll let you keep driving. The rules may change, and you will have to adapt to the changes, but you need to follow them if you want to keep driving. We may ask you to "renew" your license, but as long as you have a good driving record and are still capable of driving the car, the State will renew your license.

A responsible farm operator, even after 20 years of business, should be able to continue farming without having to go through the entire permitting process again. If it is not significantly impacting the environment and is meeting the Nation's need for seafood, then permits should be renewed.

Response to Written Questions Submitted by Hon. Bill Nelson to Donald B. Kent

Question 1. General Marine Aquaculture: What are your top recommendations for building a marine aquaculture industry while preserving our environment and traditional fisheries?

Answer. I feel we have significant existing regulatory safeguards in place to ensure that a use of the EEZ for marine farming will not have adverse impacts on traditional fishing communities, the environment or other user groups. What is needed is a consistent, predictable, efficient permitting process. This would require:

- Clearly defining the permits required to operate in the EEZ and reaffirm the limits of the legal authorities of permitting agencies to issue permits:
  - U.S. Army Corps of Engineers permit under Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) which prohibits the obstruction or alteration of navigable waters of the United States without a permit.
  - Clean Water Act authorizes the EPA to regulate point sources that discharge pollutants into waters of the United States through the National Pollutant Discharge Elimination System (NPDES) permit program.
  - The U.S. Coast Guard issues permits for Private Aids to Navigation (PATON) which includes lighted structures, lighted and unlighted buoys, RACONs (interactive RADAR transponders) and fog signals, which are installed and maintained by anyone other than the Coast Guard. Such a permit would specify the navigational aids needed for an offshore farm to avoid impacting the operations of other vessels in the area.
- A missing link at this time is a specified lead agency for the requisite National Environmental Policy Act review for all federally issued permits. When only one Federal permit is required, then the permitting agency is required to conduct a NEPA review to ensure that public concerns over prospective environmental impacts are addressed. However, when multiple Federal permits are required, as with offshore fish farms, then the NEPA review should be combined into a single, coordinated NEPA review process that is led by a "lead agency". The resulting environmental review document can then be used to condition the permits issued by the respective agencies. For consistency across all coastlines, it is important that a single agency be identified nationally as the lead agency for

the NEPA review. In my opinion, the lead agency should be NOAA Fisheries for the following reasons:

- ◦ The majority of the environmental concerns regarding fish farming are the direct responsibility of NOAA line agencies:
- ◦ Impacts to protected resources like marine mammals, endangered species, habitat areas of particular concern, etc. are managed by NOAA Fisheries
- ◦ NOAA's National Ocean Service is responsible for interactions with state coastal resource management agencies under the Coastal Zone Management Act and provides resources to coastal zone managers to adequately assess potential impacts. States with approved management plans would have review for "consistency" which is best coordinated by NOAA.
- ◦ NOAA's NOS has developed an extensive array of tools including:

- GIS based tools that identify potential farming sites by delineating bathymetric requirements needs while assessing the potential for interactions with other user groups and/or protected resources.
- Photographic analysis systems that assess visual impacts of farms to coastal residents and user groups
- Water quality predictive models that evaluate site specific characteristics (depth, current speed and direction, water temperature, etc.) to assess potential impacts to the water column and benthic habitats and mitigate them.

- ◦ NOAA Fisheries has the most comprehensive experience in the subject area of aquaculture impacts as well as the most experience in conducting NEPA reviews.
- ◦ Collectively, these actions will act to incentivize American investors to keep their capital investments here thereby creating a new paradigm for domestic seafood production toward higher food security, lower transport costs, more American jobs, a larger tax base and rebirth of our working waterfronts.

Question 2. Aquaculture Facility Siting: Mr. Kent, the ocean is very important to my state, especially for fishermen. As industries advance, we continue to see competing demands for the use of our Nation's waters. Where is the ideal location for an aquaculture facility and how should the government sort through competing ocean uses?

Answer. I agree that the health of the ocean environment around Florida is by far the State's most important asset as it contributes significantly to the quality of life of Floridians and the millions of annual visitors and ocean health is critical to the Florida economy. Tourism, military operations, commercial and recreational fishing are all critical components of Florida's economy and are all reliant on maintaining a healthy ocean ecosystem.

Relative to where to locate farms off the shores of any of our Nation's coastal states and the Great Lakes, NOAA's National Ocean Service has developed GIS based analytical protocols that can be used to answer that question. Bathymetric information exists in databases accessible to NOAA and can be used to identify areas where it is presently practical to site farms (*e.g.,* between 100 to 300 feet of depth). Much of our Nation's EEZ is too deep to accommodate the present mooring technology used in offshore farming. After determining where farms can be practically located, other databases can be accessed to further refine the locations by identifying sites that have adequate, but not excessive, current flows which act to maintain water quality for fish health and avoid degradation of the environment. These areas can then be reviewed to avoid show sensitive habitats, user groups (fishing, energy production, military operations, transportation, etc.), navigational conflicts, migratory pathways and other possible conflicts. After this type of vetting process all of which could be conducted by Federal agencies (*e.g.,* U.S. Navy, BOEM, U.S. Army Corps of Engineers, EPA, U.S. Coast Guard) interacting directly with NOS technical staff, the resulting areas should then be available with a far easier environmental review since the majority of the potential conflicts would have already been addressed in the site analysis process.

Question 3. Technology Use: Mr. Kent, I am an advocate for capitalizing on new and innovative technology. How is technology being used in the monitoring and inspection of marine aquaculture? What types of systems could be used in Federal waters?

Answer. Because of the rigors of the open ocean, farms located in Federal waters will need to be regularly inspected and maintained. Unlike fish farms located within enclosed embayments, offshore farms will need to withstand high wave and wind conditions not typically found in near-shore areas. Because of the relative depth (up

to 300 feet), it would be difficult, hazardous and expensive to rely solely upon SCUBA divers to inspect mooring and cage systems on a regular basis. Fortunately, over the past few decades there have been significant advances in the development, versatility and availability of remotely operated vehicles equipped with high resolution cameras and lighting that are capable of regular use at the required depths of operation. These ROVs can replace divers for the majority of the inspections required to maintain operational integrity and safety on offshore farms.

Large volume cages are now available that can be submerged whenever weather becomes problematic. Feed systems are available that can feed multiple cages without wasting feed thereby reducing the potential for adverse impacts. Cleaning systems are available that keep nets clean of fouling organisms which decreases hydraulic drag and improves water flow. New RADAR transponder technologies are available for automatic warning and avoidance of potential collisions.

Question 4. What have been the technological improvements over the last decade in reducing the environmental impacts of marine aquaculture?

Answer. As mentioned above, computer based site analysis can reduce conflict with other user groups, minimize interactions with protected resources and ensure minimal, if any, impacts on water quality.

Feeds are no longer completely reliant on fish meal as their primary source of protein and oil. Diets can use vegetative protein, protein from fish processing, bacterial protein from agricultural waste fermenters, black fly larvae grown on garbage and processing waste from other livestock sources.

Simulation modeling can be used to site farms in locations where the depth and adequate current flow can combine to make the presence of farms chemically undetectable and thereby avoid any impacts on water quality.

Farms can be sited far enough offshore as to make them practically invisible to people standing on the shoreline thereby avoiding aesthetic impacts to the coastal zone.

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